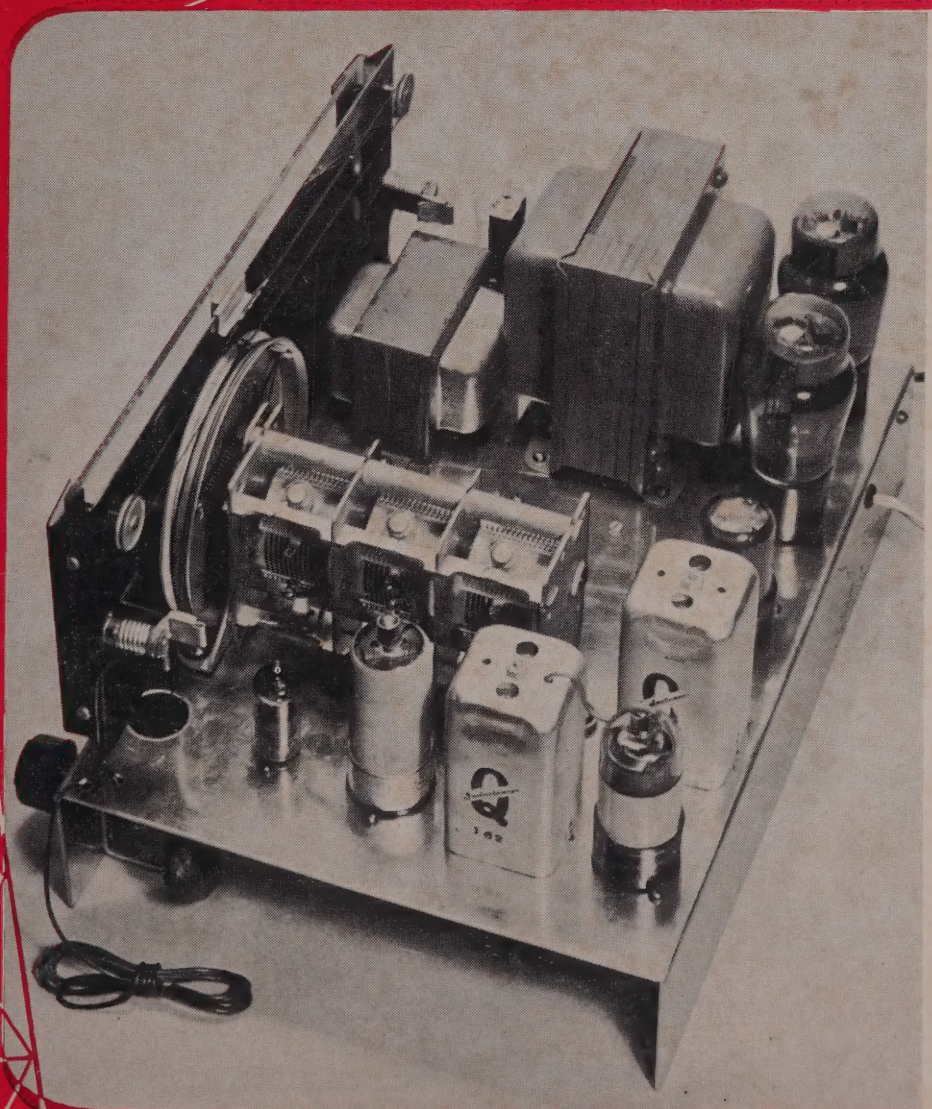
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



IN THIS ISSUE:

A Quality 7-Valve Receiver

•

A Wide-band Oscilloscope Amplifier

•

A New Variable Selectivity Circuit

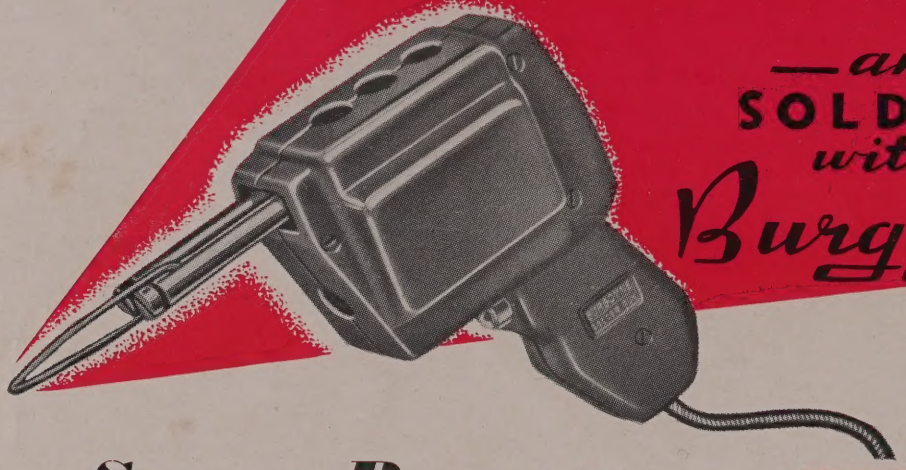
•

The Transistor

MARCH 1st, 1950 VOL. 5, NO. 1 1/10

Count S·E·V·E·N··

—and SOLDER with Burgoyne



Save Power

Help yourself to keep within your allocation

By using BURGOYNE

7 SECOND

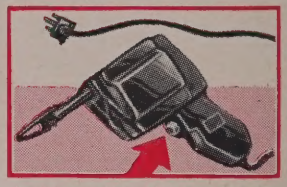
INDUCTION SOLDERING GUN

TYPE S. 472

—IT'S HOT WITHIN 7 SECONDS OF SWITCHING ON!

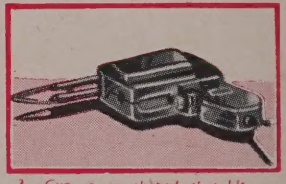
Yes! You can plug in to A.C. mains, count seven, and solder. It really is as easy as that. No one having once used this modern instrument would ever go back to the old-fashioned electric soldering iron. No service engineer is up to date without one because it saves time, fuel, and money.

Sole New Zealand Distributors:



1. All you do is plug in, press trigger button, count seven and the bit is hot enough for soldering.

2. Bit cools instantly you release trigger button. No danger of fire or burning.



3. Gun is so shaped that bit cannot touch anything when placed down. It is safe.

Order from Dealers

Swan Electric Co. Ltd.

AUCKLAND • WELLINGTON • CHRISTCHURCH • DUNEDIN

RADIO and ELECTRONICS

Vol. 5, No. 1 March 1st, 1950

Editorial 2

The "Radel" 1950 All-Wave Seven 4

A Variable-Selectivity I.F. Amplifier System 9

Publications Received:
Facsimile, by Hills and Sullivan 15
Fundamentals of Radio Valve Technique, by J. Deketh 15

The *Radio and Electronics* Abstract Service 16

A Wide-Band Amplifier for Oscilloscopes 18

The Automatic Weather-Reporting Station:
Part 2: Calibration Charts 23

The Philips Experimenter:
No. 29: Using the Aerial Coupler 24

Questions and Answers:
The New High-Quality Audio Amplifier 28
The "Radel" Frequency-Modulated Test Oscillator 28
Using Variable-Selectivity I.F. Transformers 29

For the Serviceman
The Gulbransen and Cromwell Models *727* 33

The Transistor—An Amplifying Crystal, by the Engineering Department of the Aerovox Corporation 36

The New Zealand Electronics Institute (Inc.) Newsletter 41

Trade Winds 42

The New Zealand Radio Manufacturers' Federation 43

Classified Advertisements 45

Index to *Radio and Electronics*, Vol. 4 46

OUR COVER

This month's cover photograph gives a view of the "1950 All-Wave Seven," a description of which commences in this issue. This is a set using the latest valves to give high sensitivity, on broadcast and shortwave, and which has a push-pull output stage giving quality output at low H.T. current drain.

•

CORRESPONDENCE

All correspondence, contributions, and enquiries referring to advertising space and rates should be addressed to:—

The Editor,
"Radio and Electronics,"
Box 22,
Government Buildings P.O
WELLINGTON.

OFFICES AND LABORATORY:
Radio and Electronics (N.Z.) Ltd.,
46 Mercer Street, Wellington.
TELEPHONE:
Wellington 44-919.

AUCKLAND REPRESENTATIVE:
Mr. J. Kirk,
No. 11 Keans Building,
150 Queen St., Auckland.
Telephone 48-113. P.O. Box 401.

AUSTRALIAN DISTRIBUTORS:
Messrs. Gordon & Gotch (A/sia.) Ltd

•

Remittances from Australia to New Zealand should be by international money orders or bank draft payable in New Zealand.

Sole Wholesale N.Z. Distributors FEATURE PRODUCTIONS LTD., P.O. Box 5065, Wellington.

Printed in New Zealand by H. H. Tombs, Ltd., Wingfield Street, Wellington.

GUY E. MILNE
ELECTRONIC TECHNICIAN

AN UNFORTUNATE PARADOX

Many of us are extremely interested in high-quality reproduction, and go to considerable lengths (and expense) to achieve what we consider to be an approach to the ideal reproducing system. Let us consider for a moment how this is usually done. We may start by purchasing as good and expensive a loudspeaker as we can afford. Next comes an amplifier, and with present-day circuits to choose from, not to mention the possibility of buying such parts as output transformers, with characteristics limited only by the buyer's pocket, it is a comparatively simple matter to produce the amplifier with a flat frequency response from 20 to 20,000 c/sec., and with distortion better than 0.2 per cent. total at any frequency, and full power output. Not that building such amplifiers is an easy job. It is not, but in these enlightened times it can be done, and is done every day. Several years ago, such an amplifier had not even been heard of, and if it had, would have been put down as an unnecessary refinement, or a plaything for the long-haired boys!

Having got thus far, we turn our attention to gramophone pick-ups, and make a selection from the numerous types which claim to have high-fidelity response, no resonances within the audible range, light needle-point pressure and low stiffness in the lateral direction. So far, so good, and once the appropriate compensation has been made for the constant-amplitude characteristic of the record below 250 to 300 c/sec., we should have a complete system that will reproduce music from gramophone records that is as like the original performance as is the record itself.

Up to a point, this is true enough, but the unfortunate fact emerges that most of our records sound poorer than when they were played on an instrument with nowhere nearly as good frequency response, and probably with more distortion too. When this happens, we are greatly discouraged, as we undoubtedly have some reason to be, and perhaps even conclude that this high-fidelity business is only a stunt on the part of various manufacturers, with no basis of fact!

Such a conclusion is by no means true; if not, where is the fallacy, and why do we not like the results from what may be reckoned the best equipment? The most likely reason is the noise-level, with distortion a close second, not entirely separable from the noise.

The noise part of this argument is evident enough to any one who has heard a wide-range reproducer functioning, but the cry of "distortion" may seem a little far-fetched in view of the fact that we have specified very good speaker, pick-up, and amplifier characteristics. It is not, however, when we come to examine the record itself, and the mechanical implications of playing it, even with a light-weight pick-up.

Why, in the first place, should we assume that a record is itself distortionless. This may seem like heresy, but there is no reason for putting the recording process on such a pedestal, particularly when it is well known that numerous sources of distortion exist, even in the pressing process, and assuming that the electrical part of the process is perfect. Indeed, the surprising part of it is that recordings can be as well made as they are, not that a little distortion sometimes occurs! Then again, assuming that all one's records are technically above reproach, there is the mechanical problem of the pick-up itself.

It is unfortunately true that no sort of standardization exists with regard to the shape of the groove in various makes of record, and even from one record of a given make, if one is much older than the other. In theory, and in practice too, it is not possible to design a pick-up stylus unless the shape of the record's groove is known. If it is, the stylus can be given the best possible radius for playing that particular record, and there is a fair chance of all being well. As it is, many types of groove have all to be played with the same stylus, and some mechanical effects come into play which can and do have a very distressing effect on the quality of the reproduction. There is no space here to enlarge on these things, but the chief offender is the so-called "pinch" effects.

In combating these difficulties, two methods of approach are possible. The first is to have a number of replaceable pick-up heads, each with a stylus of different tip radius. The other, and more universally applicable method is to use low-pass filters to limit the frequency response to specific values at the high end of the scale. If a number of such filters are available, allowing the response to be abrupty terminated at several fixed frequencies at will, the result is that records of different sort, and of different qualities, can be successfully played with the one pick-up head. The best records will not need any top cut at all, and successively poorer ones can be used satisfactorily with greater degrees of top cut. This sort of treble control should not be confused with the ordinary "tone control" type of circuit, which starts to attenuate at some quite low frequency, and tends to spoil the music without making much improvement as regards removing noise and "hash."

The paradox should now be obvious enough. It is that we go to a great deal of trouble to get a system that is linear in response up to supersonic frequencies, and then at one stroke, we appear to throw away the advantages we have striven so hard to achieve. However, the situation is not so grave as this, and in practice the excellence of the speaker and amplifier is by no means wasted. Just how, we will attempt to describe at a later date. We hope also, in an early issue, to present some circuits which can be used to produce the desirable sharp cut-off at high frequencies.

The pick-up you've waited for

...a new miniature light-weight moving iron pick-up

A fascinating piece of precision engineering —the head being only half the size of its competitors — constant velocity type — no attempt being made to compensate for the loss in recording frequencies below 300 C.P.S. This has enabled the removal of bass resonance below 30 C.P.S. and allowed a very free needle mounting and good tracking down to this figure. At double pianissimo or double forte there is no distress, and at full amplification on a three-stage amplifier there is no distortion of bass or treble notes. Needle chatter is reduced to the point of inaudibility.

Moving Masses: **Reduction in moving weight reduces record and needle wear.**

Armature: **Oil damping eliminates treble resonance above useful recording and width of magnet gap reduces possibility of amplitude distortion to minimum.**

Coil: **Of high impedance—1,300 ohms at 1,000 C.P.S.; the correct working load required across pick-up is 10,000 ohms.**

Output: **Direct from pick-up terminal is 1/10 volt, which will fully load a three-stage amplifier. Bass lifting in the amplifier is required at a lift of 15 db. at 50 C.P.S. from the 300 C.P.S. mark; a treble control is advised to suit the individual recording, as the response of the pick-up falls only 5 db. at 8,500 C.P.S. and 9 db. at 12,000 C.P.S. A coupling transformer is supplied to slip the voltage up to 5 volts, which will then fully load the standard commercial set.**

New Zealand Distributors:

TURNBULL & JONES Ltd

Auckland Wellington Christchurch Dunedin
Hamilton. Palmerston North Invercargill

THE "RADEL" 1950 ALL—WAVE SEVEN

The next in our new series of sets for home-constructors is a seven-valve all-wave receiver with push-pull triode output stage, without negative feedback. The set has excellent quality of reproduction, and an output of approximately five watts, which is ample for the average home set. Provision for using a pick-up to make the set into a radio-gram combination is easily made, and the audio gain is ample for most modern pick-ups. The cost is not exorbitant, since modern low-consumption valves give a total H.T. drain of only 100 ma.

INTRODUCTION

In designing our new series of sets for home-constructors and others, we have decided that one feature that is quite indispensable is the use of the latest valve types wherever possible; there are two main reasons for this, firstly that the more recently-developed valves will undoubtedly give higher performance than the older types, and secondly that as a set can be expected to have a life of several years if well constructed, with parts of good quality, the more modern valve types will enable valve replacement to be made more easily in the future, when types that are old now can be expected to have become obsolete and difficult to obtain even for replacement purposes.

Accordingly, the line-up of this set comprises (1) a 6BA6 miniature R.F. pentode as R.F. amplifier, (2) an X61M as oscillator-mixer, (3) a 6AR7-GT as I.F. amplifier and detector-A.V.C. rectifier, (4) A 6SN7-GT as audio voltage amplifier and phase inverter, (5) two KT61's as push-pull output stage, and (6) a 5Y3 as power rectifier.

These are all very modern valves, as far as this part of the world is concerned. In fact it is only fair to warn readers that the X61M, 6AR7 and KT61 may as yet be a little difficult to come by, owing to their newness on the catalogue. However, we have not departed from our principle of trying to use only those components that are readily available, because all these valves are being manufactured in Australia, from where all our American type valves come from now that no direct imports come from dollar sources. We have been informed, however, that by the time this article is printed, ample stocks of all these types will be available here.

IDEAS BEHIND THE DESIGN OF THIS SET

When a new set is presented in these pages there are always a few main ideas round which the design centres, and we have always made it a practice to describe these in some detail, so that the reader may get an accurate idea of just what sort of set he is getting. The ideas of some of the older radio magazines seemed to be directed rather to convince the reader, simply by reiteration, that each set presented was the best ever seen with four, five, or however many valves it used. This approach is palpably nonsense, and some magazines even today seem to employ it with more or less success. That sort of thing may be well enough for the enthusiastic but not very knowledgeable reader, but today most constructors know that there is no such thing as a "best" seven-valve set, and that a design containing a given number of valves may be excellent for some special purpose, and almost useless for another. In describing a set which we ourselves have designed, we believe that not only the specially good features, if any, should be stressed in the article, but also that its limitations should be pointed out, so that every reader may weigh up the whole thing and decide for himself whether or not the set suits the purpose he has in mind.

Accordingly, here is a list of features belonging to the "1950 All-wave Seven."

(1) Good audio quality, without the use of negative feedback.

(2) No special arrangements for improving the audio frequency response for radio reception compared with the average receiver, *i.e.*, no variable selectivity circuits, or specially difficult features in the R.F. or I.F. parts.

(3) All-wave coverage, without band-spread, from broadcast to 20 mc/sec., in three bands.

(4) High sensitivity and good short-wave performance through the use of modern high-gain R.F. amplifier and oscillator-mixer valves.

(5) Low cost for the number of valves, owing to a type of circuit which eliminates several small components without sacrificing efficiency or stability.

(6) Somewhat higher audio power output than the average set with single-ended output, but less than that of many sets with high-powered push-pull output stages. This also helps considerably in keeping costs down.

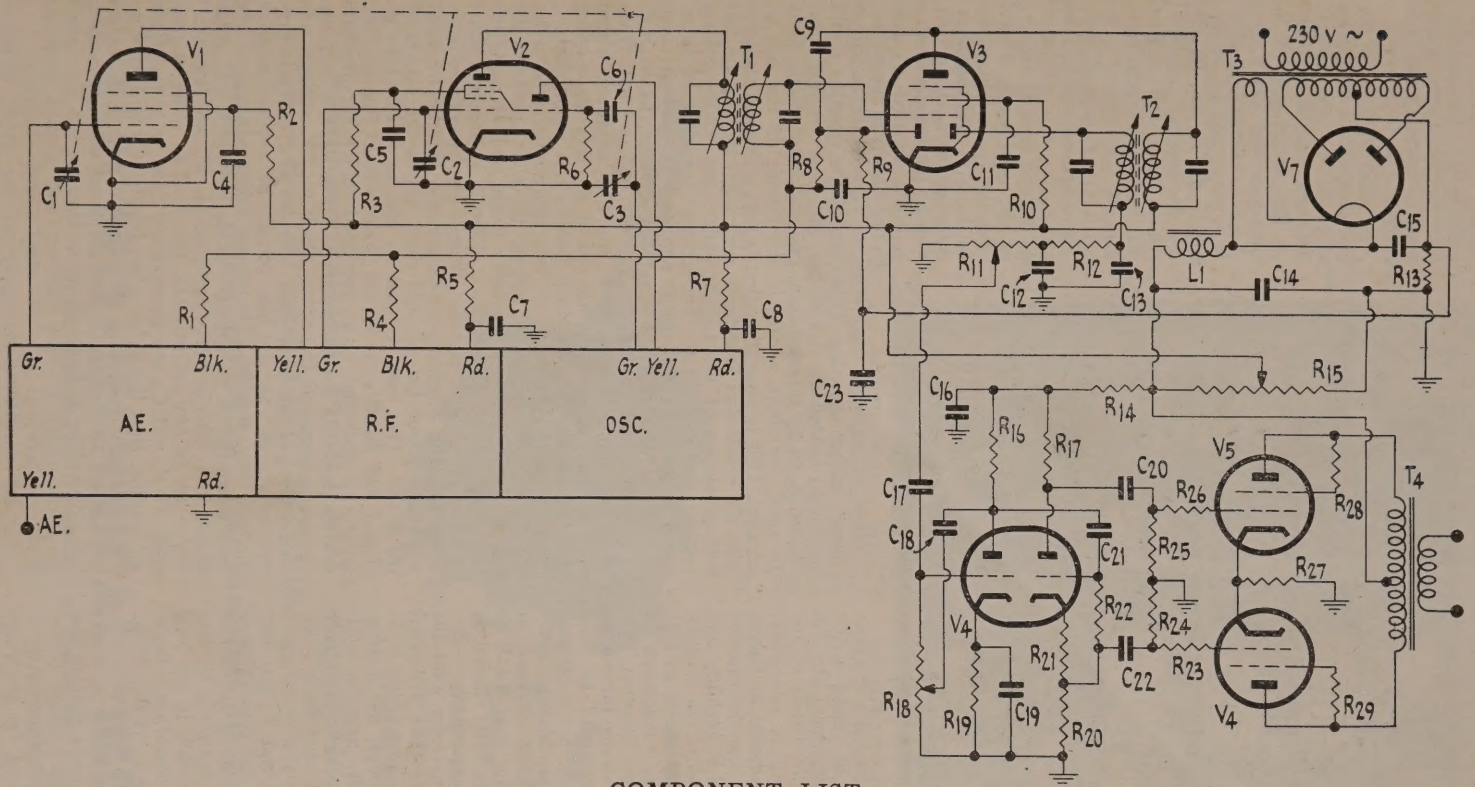
(7) Ease of construction, with straight-forward, easily-made chassis.

It will be noticed that some of these features appear to be negative in character; for instance, it is stated that there is *no* variable selectivity incorporated, nor any negative feedback. Taken together, these two boil down to the fact that while the set has been designed for better than average quality, it does not fall within the so-called "high-fidelity" class. In consequence, it is essentially simple, and therefore easy to construct, while the cost is only slightly in excess of that of a 6-valve set with only ordinary audio quality and power output. Also, there are no difficult adjustments to make that really need a laboratory's facilities, either in the audio or the R.F. end. The receiver is therefore, just what it claims to be, namely a better-than-average performer, especially suited to construction by the amateur.

THE CIRCUIT ARRANGEMENT

As can be seen from the circuit, a commercial three-band coil unit is used. These units can be obtained from more than one maker, and as well as saving the constructor much work, give the completed set a performance that he would find difficult, if not impossible, to achieve if he attempted to build a coil unit himself. The dial is one sold by the maker of the coil unit, and designed to track with it, assuming that the recommended kind of gang condenser is used. It should be pointed out that it is quite possible to build the set using a unit other than the one built into the prototype, and that if this is done, just as good performance should be obtained. It may be necessary, though, to modify slightly the chassis lay-out, especially so far as the mounting of the R.F. amplifier and oscillator-mixer valves, and the dial are concerned. Apart from this, no changes should be needed in the circuit if a different make of unit is used.

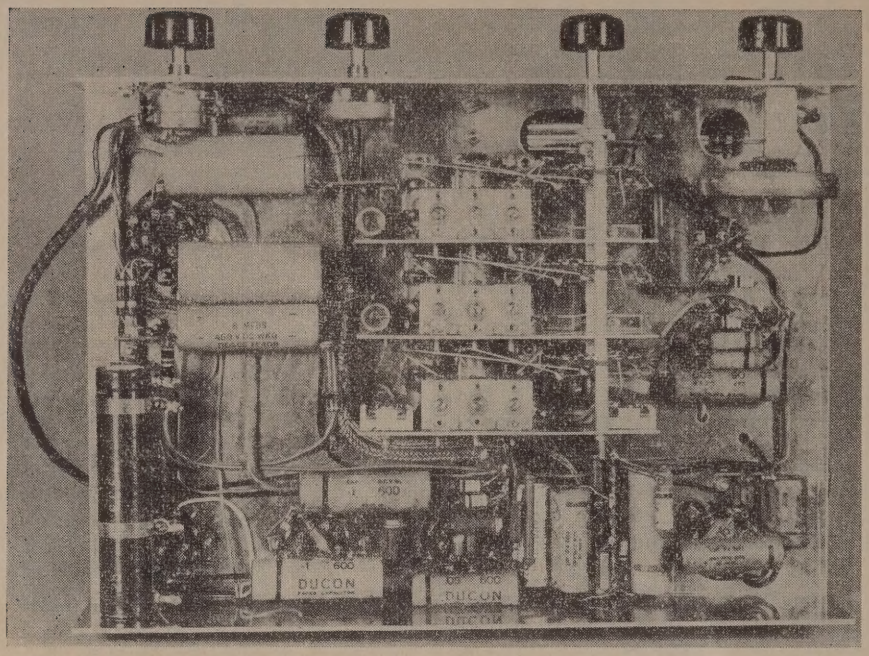
Although many manufacturers are in the habit of designing their circuits in such a way as to eliminate cathode resistors and bypass condensers wherever pos-



COMPONENT LIST

V_1, 6BA6
V_2, X61M
V_3, 6AR7-GT
V_4, 6SN7-GT
V_5, V_6, KT61
V_7, 5Y3
R_1, R_4, R_{10}, R_{16}, 100k.
R_2, R_6, R_{12}, R_{17}, R_{20}, 50k.
R_3, 15k.
R_5, R_{21}, 2k.
R_7, 35k.
R_8, R_9, 1 meg.
R_{11}, R_{18}, 500k. Pot.
R_{13}, 25 ohms.
R_{14}, 30k.
R_{15}, 25k. voltage divider, with one tap.
R_{19}, 1k.
R_{22}, R_{24}, R_{25}, 250k.
R_{23}, R_{26}, 10k.
R_{27}, 150 ohms.
R_{28}, R_{29}, 100 ohms.
C_1, C_2, C_3, 420 $\mu\mu$f. max. cap. 3-gang.
C_4, C_5, C_7, C_8, C_{17}, C_{21}, C_{23}, 0.05μf.
C_6, C_9, C_{12}, C_{13} 50$\mu\mu$f. mica.
C_{10}, C_{11}, C_{20}, C_{22}, 0.1μf.
C_{14}, C_{15}, 16 μf. 450v. electro.
C_{16}, 8μf. 450v. electro.
C_{18}, 100 $\mu\mu$f. (or larger, see text).
C_{19}, 25μf. 25v. electro.
T_1, T_2, 45 kc/sec. I.F. transformers.
T_3, 310-0-310v., 100 ma. power transformer.
T_4, output transformer, 6000 ohms, p.-p. to v.c.
L_1, 100 ma. smothing choke.

Important Note.—A 10,000-ohm resistor, not shown, should be connected between the screen of V_2 and chassis.



containing the A.V.C. diode, the usual way of providing delay voltage is simply to allow the cathode to be positive with respect to the diode plate by earthing the load resistor.

In the wiring to the coil unit, shown simply as a block on the circuit diagram, the black leads in the aerial and R.F. compartments carry the A.V.C. voltage to the R.F. stage and mixer respectively. R_1 and R_4 are the de-coupling resistors, which in a full circuit diagram have bypass condensers connected to earth from the coil end. These are not shown, because they are included in the coil unit. However, in the read leads, which take the H.T. voltage into the R.F. and oscillator compartments, no provision by bypass condensers is made, so that C_7 and C_8 are shown on the circuit

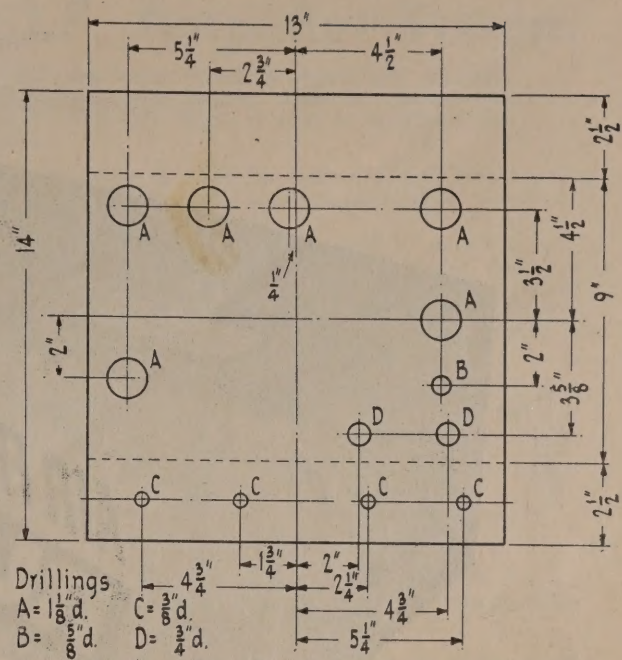
sible, this is not often seen in circuits intended for home-construction. The reason is possibly to be found in the fact that the use of a back-biasing arrangement for the whole set is apt to introduce hum in the hands of inexperienced builders. Nevertheless, there is one great advantage of back-biasing, in that all cathodes of valves supplied with grid voltage in this way can be directly earthed to the chassis. This improves R.F. stability and eliminates two components for every valve so treated. In this case three of the valves are back-biased, so that three cathode resistors and their bypass condensers do not have to be used. The audio stages, however, use cathode biasing in the ordinary way. But since the output stage is push-pull, no bypass condenser need be used there, and only the voltage amplifier stage has a cathode bypass condenser. The objections to back-biasing apply with most force to audio stages, which are prone to pick up hum in this way, so that leaving only the R.F. part of the set with back bias leaves very little chance of trouble from this cause. To obtain approximately —2v., a resistor R_{13}, of 25 ohms, is placed in series with the power transformer centre-tap, which is thus grounded through the resistor instead of directly. The whole H.T. current of the set therefore flows through the 25-ohm resistor, making the ungrounded 2 volts negative with respect to chassis. In order to decrease the hum voltage across the back-bias resistor, the first smoothing condenser is connected not to earth, but to the transformer centre-tap. The grid returns of V_1, V_2, and V_3 are then connected together and taken to R_{13}. If the connection is traced through the set from the upper end of R_{13}, it can be seen to go not only to the grid circuits of V_1, V_2, and V_3, but also to the lower end of R_9, which is the load resistor for the A.V.C. diode. There is therefore a negative potential of 2 volts placed on the plate of this diode. This gives a 2-volt delay to the A.V.C., preventing this from coming into action until the aerial signal is strong enough to produce an I.F. signal of 2 volts peak at the plate of the I.F. amplifier. On very weak signals, therefore, the A.V.C. does not work, and the full sensitivity is realized. Where a cathode resistor is used for the valve

When we examine the circuit of V_3, we can see that it appears rather crowded. This part of the drawing could have been spaced out somewhat, but this was not done, advisedly, so as to emphasize one important point. It is the need for short wiring in the circuit of the A.V.C. rectifier. This is something that is very often not realized, with the result that long leads are made carrying the full voltage output of the I.F. amplifier, and simply asking for the set to oscillate. The general principle of keeping R.F. and I.F. leads short applies with greatest force to those leads carrying the greatest voltage. In an R.F. stage, the signal voltage can be reckoned in small fractions of a volt, but not so in the I.F. amplifier, where even 50 volts of signal is not out of the way under some circumstances. If then a long lead is run round the set, carrying an I.F. voltage of this magnitude, it is a bit hard to expect it not to radiate to other parts of the set, where it will most probably cause oscillation. Often the valve line-up does make it difficult to preserve short leads in the A.V.C. rectifier circuit, but here there is no difficulty. The blocking condenser, C_9, can be mounted with only about $\frac{1}{4}$in. of lead right across the socket of the 6AR7. The load resistor R_9 can be attached to its "high" end directly on to the diode contact lug, and the other end anchored to an insulated solder lug mounted nearby especially for the purpose. Then, right at this lug, should be mounted C_{23}, after which no I.F. voltage will be present on the lead which goes to C_{15}, and this may wander as far as we like round the chassis without causing any trouble. The same thing applies to the lead from the A.V.C. diode's plate to the A.V.C. filter resistor R_8. This is where many people slip up. *It is most important in any set* to make this lead as short as possible. If R_8 and C_{10} are mounted as close up to the diode as possible, then the A.V.C. line leaving C_{10} will have no I.F. voltage, but only the D.C. control voltage on it, and it also can be run as far as we please without causing instability. The object lesson in drawing the V_3 circuit very compactly is now obvious and should need no further labouring!

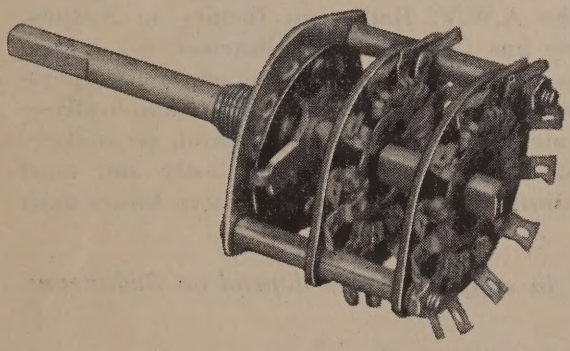
Similar considerations apply to the diode detector,

where high I.F. voltages also occur. Here, the important thing is to keep the I.F. filter consisting of R_{12}, C_{12}, and C_{13}, as close as possible to where the lead from the second I.F. transformer comes through the chassis. At the left-hand end of R_{12} there should be a high audio voltage, but very little I.F. voltage, so that the lead connecting R_{12} to R_{13} should not be a source of I.F. instability. However, where as here, the diode load resistor R_{13} is used also as the audio volume control, and must therefore be on the front of the chassis, some way from R_{12}, it is usual as a safety measure, to shield the lead and this should always be done.

The audio section of the receiver is quite conventional and does not need much comment. The first half of V_4, the 6SN7, is used as a voltage amplifier, with a gain of approximately fourteen times. Then comes the phase inverter, of the reliable and well-balanced split-load variety, which in turn feeds the grids of the push-pull stage. The use of KT61's, triode connected, gives an amplifier with a power output of 5 to 6 watts, with the usual good triode quality, but in this case with very high sensitivity. Only about 9 volts peak is required to fully swing each valve, which is a far cry from the old 45 or 2A3, which needed over 40 volts of undistorted output from the preceding stage before the full output could be realized. Thus, with only one very low-gain voltage amplifier stage, and a phase inverter which provides a slight loss in each side rather than any gain, the whole audio section can be fully loaded by rather less than a volt R.M.S. of audio signal from the detector. Since this will provide about 20 volts or so on strong local signals, this means that the volume control will be advanced only very slightly for most listening purposes, and still not very far even for full output from the amplifier. This has a beneficial effect on the detector diode, as it reduces considerably the shunting effect of the grid resistor R_{18}, which is tapped across only a very small portion of the load resistor R11. Detector distortion, which can often be very violent, is thus reduced to a minimum.



Continued on Page 45.



"OAK"

Switch Service

Do not discard "OAK" Switches before consulting us. Worn-out and noisy switches can be rebuilt with new wafers. Other brands of switches duplicated in "OAK."

Switches available for "Radel" Signal Generator ***(December issue of "RADIO and ELECTRONICS")***

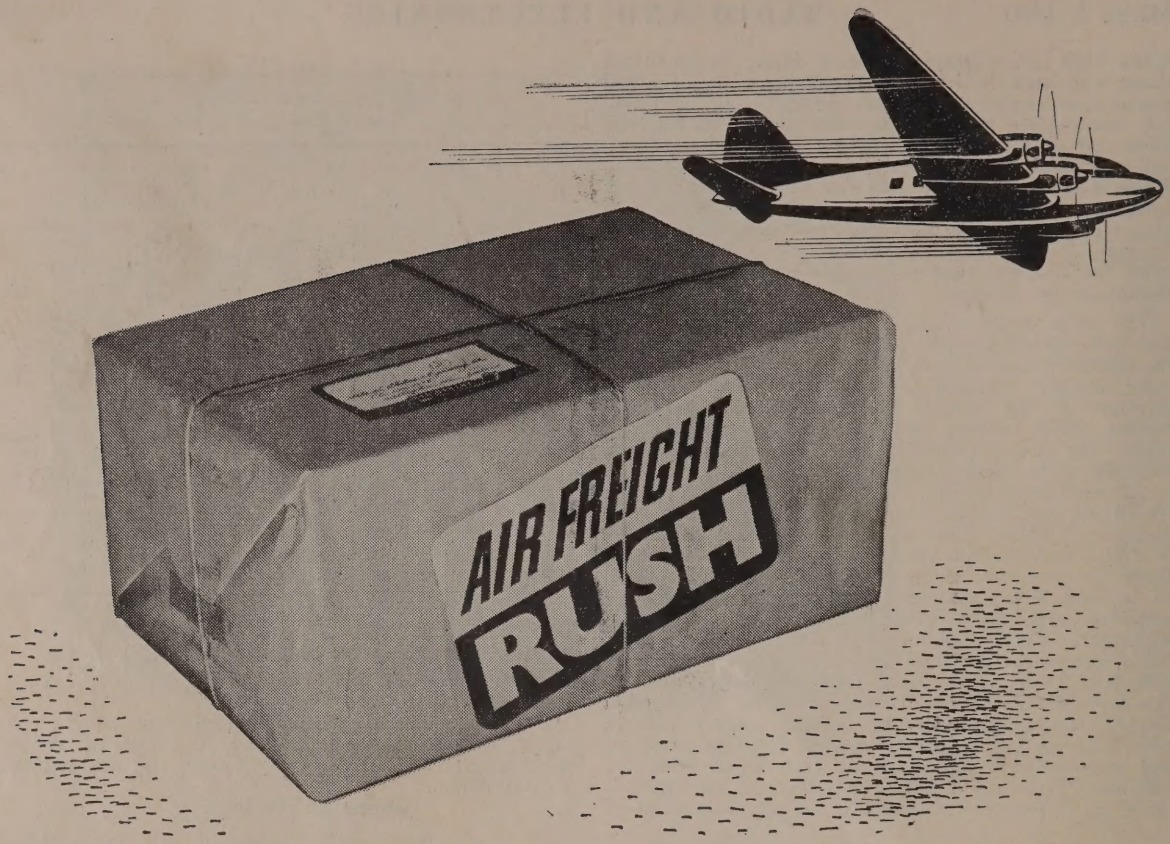
Switches made up to any specification in large or small quantities

•

ELECTRO-TECHNICAL INDUSTRIES LTD.

Manufacturers and Importers of Radio and Electrical Apparatus

C.P.O. BOX 847 :: :: :: :: 85 VIVIAN STREET, WELLINGTON



Yesterday a manufacturer asked for a quantity of valves short-stocked in New Zealand. Today a rush order leaves the A.W.V. Radiotron factory in Sydney. Before the week-end the manufacturer has the wanted Radiotrons.

As every radio man knows Radiotrons give utterly dependable service in operation. To this service add a supply-service that no other valve can match, firstly—through the network of Radiotron dealers throughout New Zealand, secondly—through the eight branches of the N.E.E.Co. as distributors, lastly and most importantly, through the A.W.V. Radiotron factory only eight aero hours away in Sydney.

For service in operation and service in supply you can depend on Radiotrons.

Radiotron
VALVES

New Zealand Distributors:

The NATIONAL ELECTRICAL and ENGINEERING Co., Ltd.

AUCKLAND WELLINGTON CHRISTCHURCH DUNEDIN HAMILTON
WANGANUI HASTINGS INVERCARGILL

A Variable-Selectivity I.F. Amplifier System

Many schemes have been put forward for variable selectivity, which is universally desirable for radio sets with any pretensions towards high-quality reproduction. Here is a simple one that gives results equal to those of more complex ones, but which is easy to construct and adjust.

INTRODUCTION

There should be little need these days to enter into lengthy explanations of the desirability of variable selectivity, especially in the case of receivers which pretend towards high quality. The subject has been treated in considerable detail in previous articles in this and other periodicals, and we are sure that most quality enthusiasts are convinced of its desirabiilty. The rub comes when an attempt is made to find a suitable method of applying it. It goes without saying that as an "extra" in the design of a set, variable selectivity implies added expense of some sort, and however desirable a circuit innovation may be, it cannot often be used regardless of economics. Another trouble with many of the existing methods is that they are difficult to adjust, and sometimes, to keep in adjustment. Others again require components that are not available. Some are restricted to giving two selectivity positions only. It may therefore be of assistance to outline the desirable features of a variable-selectivity system, and to weigh up the one propounded in this article in the light of the requirements.

REQUIRED FEATURES OF A VARIABLE-SELECTIVITY SET

The features that may be considered most desirable are:—

(1) The additional components and wiring compared with a fixed-selectivity set shall not represent too great an outlay.
(2) The finished set should have as good or better adjacent-channel selectivity than a normal one.
(3) The alignment of the set should if possible be no more difficult than a normal set's, and should require no greater number of adjustments.
(4) Components used should, if possible, be standard parts, and a minimum of specially selected or close-tolerance components should be used.
(5) Once adjusted, the variable-selectivity circuit should be no more subject to drift than a normal set.
(6) If possible, the system should cater for as few or as many selectable band-widths as may be desired, and without undue complication.
(7) Use of the selectivity control, whether stepped or continuous, should not necessitate re-tuning.
(8) The system used should be electrical rather than mechanical in nature, thus ruling out the method of the I.F. transformer with mechanically varied coupling between windings.

This list may at first sight appear a little fearsome, but when some of the available methods are considered, it is seen that some of them fulfil some of the conditions very readily. In fact, one scheme, which was described in fairly recent issues of *Radio and Electronics*, coped with all the requirements very well, with the exception perhaps of the first and fourth. The method referred to is the one where a simple bottom-capacity-coupling is modified by the insection of T or π section filters, in such a way that the coupling between the two windings is altered without changing their tuned frequencies. This scheme worked very well indeed, but was rather costly in parts, since a number of condensers of odd values had to be used, and the values had to be correct to within 5 per cent. if no de-tuning was to be caused by the selectivity switch. Apart from this, it was excellent in all respects, as it could be made for two, three, or any number of selectivity positions, and fulfilled requirement No. 3, above, as well.

However, a new system has come to our notice, which has all the advantages of the previous one, and at the same time uses fewer parts, with less stringent requirements as to exact values. For more than three selectivity positions it would possibly become a little unwieldy, but

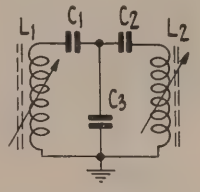


Fig. 1

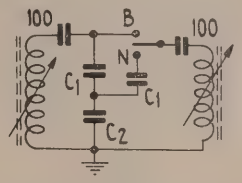


Fig. 2

Basic coupling method and the two-position system developed from it.

then it is doubtful whether more than three positions are needed in any case. It should be remembered that we are not discussing the communications type of receiver, where if stepped selectivity control is used, it is desirable to have a large number of positions, including some giving crystal sharpness.

ELEMENTS OF THE NEW SYSTEM

The variable-selectivity circuit given here is taken from British Patent No. 598662, and an abstract of the specification may be found in the *Wireless World* of January 1949. It, too, is a variation of the bottom-capacity-coupling method of coupling two tuned circuits together, and is very simple and ingenious. For the sake of those who may not be familiar with the basic coupling method by name, we will describe it first, and show how the variability is achieved by the inventor.

Fig. 1 shows two tuned circuits, coupled by the so-called bottom-capacity method. In an I.F. amplifier, which is where this circuit will be applied, we are at some pains to have all the tuned circuits adjusted to the same frequency—usually 445 kc/sec.—and we can take it that the circuit whose "bones" are shown in Fig. 1 will be used in place of one of the more normal I.F. transformers, where inductive coupling is used, simply by placing the coils of the two tuned circuits close to each other. It is well known that if the windings of such a transformer are first tuned to the same frequency, and then coupled together more closely than usual, the main result is that two response peaks appear, with a dip between, thereby giving the amplifier a response curve that has, for all practical purposes, a broad top rather than a narrow one. The essential part of this scheme, which is very simple in theory, but difficult to carry out successfully for mechanical reasons, is that both windings are tuned to the *same frequency*, but that the coupling is greater than critical. (*Critical* coupling is when the two separate response peaks have just not appeared, and any further increase in coupling will cause them to arrive.)

However, inductive coupling is not the only way in which two tuned circuits can be coupled together,

although it is the method which uses fewest components, and is therefore most used. Fig. 1 is one of the many other ways of doing the same thing. Here, we have two tuned circuits, and although they appear as one complex circuit, it is quite easy to separate them in the mind's eye. It is also possible for them to be tuned to different, or the same frequencies, just as with the better-known inductive method. It is also possible for the coupling between them to be varied, though this time it is by varying one of the condensers, and not by varying the spacing between the coils. In fact, for the coupling to be determined, as it should be, by the condenser values, and by them alone, it is necessary for there to be no inductive coupling at all between the two coils. Briefly, one should be shielded from the other if we are to be

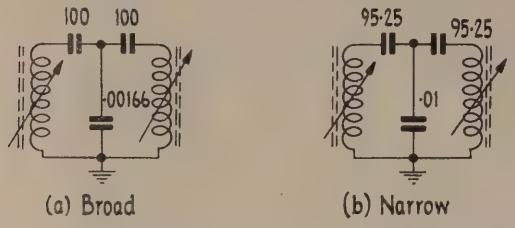


Fig. 3.—Equivalent circuit of Fig. 2 when in the two positions, with sample values inserted.

able to predict what the performance of the circuit will be. Actually, the variation in coupling can be brought about by varying C_3. At this point we can hear a number of voices raised in protest. One is saying that we can't do this without altering the frequency to which both circuits tune. Another is complaining that its owner can't yet see two tuned circuits anyway, and how can we, or anyone else tell what frequencies the two, if they really exist, are tuned to!

Well, we have a nice rule of thumb which immediately disposes of both objections. It is this: To find one tuned circuit, imagine one of the coils removed; L_2, we will suppose. This leaves L_1, C_1, and C_3, which obviously enough make a tuned circuit. C_2 is still there, but as only one end of it is connected to anything, it cannot affect the issue. To find the other tuned circuit, imagine the other coil removed, leaving the condensers and L_2. Having got thus far, it is a simple matter to see to what frequencies L_1 and L_3 are tuned. Thus, the series combination of C_1 and C_3 tune L_1, while the series pair C_2 and C_3 tune L_2.

It is also fairly obvious that if $C_2 = C_3$, then with identical values of L_1 and L_2 both circuits must be tuned to the same frequency. Now, if C_3 is altered ,while the rest of the circuit remains the same, the coupling will be changed, but so too will be the tuned frequency. Both tuned circuits will still be on the same frequency, if C_1 and C_2 are equal, but if C_3 has been made larger, this frequency will be lower than the original one, and if smaller, higher.

This is the reason why it is not possible to use a variation of C_3 as our variable selectivity control. In the normal course of events, a change in C_3 needs changes in both the other condensers if the amplifier is to remain tuned to the correct frequency. This could be done, of course, but it would need very exact adjustment, and would be very hard to adjust properly, for reasons which we need not go into now.

After all this preamble, then, we have at last come to the reason why an invention is necessary at all, in order to make the bottom-capacity coupling method suitable for a variable-selectivity circuit. The purpose of the invention is to allow a modified bottom-capacity system to give variable coupling between the two circuits, but at the same time to retain both circuits at the original tuned frequency.

HOW IT WORKS

This is shown in Fig. 2. Here, we have the circuit of Fig. 1, with the addition of only two fixed condensers and a simple on/off switch. Two of the fixed condensers, which correspond to the numbers C_1 and C_2 in Fig. 1, are labelled 100 $\mu\mu$f. This is because we have assumed that the coils used are intended to be tuned with approximately 100 $\mu\mu$f. Compared with these condensers, all the others are very large, so that the effective tuning capacity is very slightly smaller than 100 $\mu\mu$f., and well within the range that can be covered by the variable inductance tuning. The three condensers that have to do with the variable coupling are C_1, C_2, and C_3. In order to show what happens when the switch is worked, we have drawn Fig. 3, which shows the equivalent circuits for the broad and narrow positions. At the broad position, we have, tuning the left-hand coil, 100 $\mu\mu$f. in series with C_1 and C_2. Tuning the right-hand coil, we have 100 $\mu\mu$f. in series with C_1 and C_2, so that both are tuned to the same frequency. In this position of the switch, the right-hand C_1 is out of circuit, as only one side is connected. Thus, the coupling condenser, corresponding to C_3 in Fig. 1, consists of C_1 in series with C_2. Now, if we switch to the narrow position, both condensers C_1 are now in circuit. By imagining the coils to be absent, in turn, as described above, we see that each coil is still tuned by a capacity consisting of 100 $\mu\mu$f., in series with C_1 and C_2. Thus, by switching to the narrow position, we have not altered the tuned frequency of the circuits at all, unless by chance the two C_1's should not be equal as they are supposed to be. But we have altered the coupling condenser, which now consists of C_2 only. From Fig. 3, it can be seen that with representative values inserted, the equivalent circuits on broad and narrow have exactly the same form, but that the values

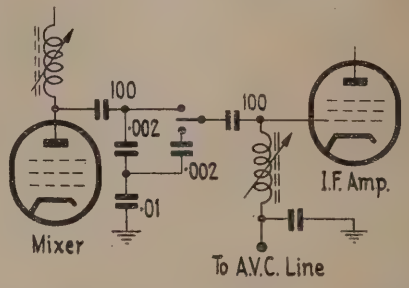


Fig. 4.—Practical circuit for the two-point scheme. Bias and screen-grid potentials are supplied to the tubes in any of the normal ways, and a conventional I.F. transformer follows, in the plate circuit of the I.F. stage.

have been changed in the way indicated above. The values inserted were 0.002 μf. for C_1, and 0.01 μf. for C_2, and the equivalent circuit values are as shown on Fig. 3. If the tuning capacities are worked out from this figure, it will be seen that for both positions, these are identical, while the coupling condensers are different by a ratio of almost 10 to 1. As yet, we have not described how it is decided what values of coupling condenser are needed to give broad or narrow pass bands, but this will be done in the next paragraph.

HOW SELECTIVITY IS DETERMINED

In order to see what kinds of value are needed for the coupling condensers to give specific types of selectivity curve, let us go back to the basic diagram of Fig. 1.

We have already seen that C_1 in series with C_3 determines the frequency to which L_1 is tuned. How, then, do the condenser values determine the degree of coupling between the two tuned circuits? In expressing the degree of coupling between any two tuned circuits use is made of the coupling factor *k*, which expresses the coupling as a fraction. A coupling factor of 1 indicates that all the magnetic lines of force generated by the primary winding are also linked with the secondary. It is clearly impossible to have tighter coupling than this, so that in

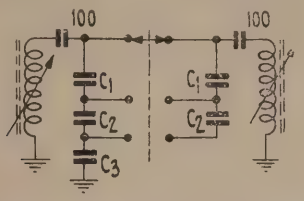


Fig. 5.—Basic system for three selectivity positions. This can be extended to embrace any number of switch positions, two extra condensers being needed for each additional position.

practice, all transformers, whether iron-cored, as in audio or power work, or air or dust-cored, as in R.F. and I.F. tansformers, have coupling factors less than unity. In iron-cored transformers, the aim is to have as much coupling as possible, but in R.F. work, we only need very small degrees of coupling. The behaviour of tuned transformers is now well enough known to all radio men, but we have already mentioned the main feature in an earlier paragraph. If the coupling is less than a certain critical amount, a response curve is produced with only a single peak, and which gives us, over fairly wide limits, a selectivity close to the maximum possible that can be got with the actual coils used. When this critical coupling, as it is called, is exceeded, *two* peaks appear in the response curve. With inductively coupled transformers, these peaks appear one on each side of the centre-frequency, which is the one to which the circuits have been tuned. Thus, with more than critical coupling, the response curve has a broad top, far wider than can be got with coupling factors less than the critical value. If the circuits are greatly over-coupled (as it is called when critical coupling is exceeded) the two peaks in response are quite wide apart, and a pronounced dip appears between them, and exactly on the centre-frequency. An example of this can be seen in curve (*a*) of Fig. 6, to which we will refer later. Thus, if some means can be found to fill in the dip in the response curve which occurs with very tight coupling, we will have a selectivity curve with a wide, nearly flat top, which is what we want for good reproduction, of the higher notes transmitted.

The numerical relation which tells us just what coupling factor we want in order to get a response curve that has this desirable wideness, is very simple, and is exceedingly useful, because it enables us to work out the values of condensers for the present scheme very easily. Most of all we want to know how we can tell when critical coupling has been exceeded. Then, if we make one position of the selectivity switch provide a coupling that is slightly less than critical, we will have the right sort of selectivity curve for listening to distant stations, on which there is too much noise of one sort or another to allow a broad response curve to be used without annoyance. Also, we can give ourselves a wide position by making the coupling factor several times the critical value, and then taking steps to fill in the dip that shows up on the centre frequency. This will give an excellent two-position system that will cover many requirements. For a more comprehensive scheme, we can have say, three positions. The broad and narrow positions can have the same characteristics as those for the two-position system, but the third can give us something intermediate between the two, that will give better reproduction of high notes than the narrow, but which will not let as much noise through as the broad when the station is a comparatively weak one. Here, then, is the important relation governing the value of the coupling factor *k*. It is:—

$$k.Q = 1.$$

Here, *k* is the coupling factor, and *Q* is the Q-value of the coils used. For example, supposing that the coils have a *Q* of 100, which is not out of the ordinary these days, the equation tells us that for critical coupling, *k* must be 0.01. Thus, for the two-position selectivity system, we should have a coupling factor of, say, 0.008 for the narrow position, and perhaps 0.05 for the broad one. We need the narrow coupling factor to be slightly less than critical, because by doing this we get slightly better selectivity, which is a help when we are receiving distant or short-wave stations, when selectivity is more important than fidelity.

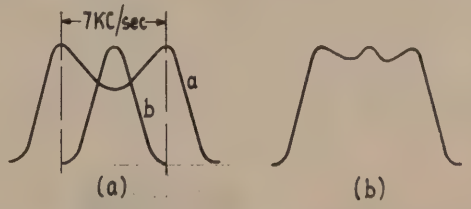


Fig. 6.—Illustrating how the over-coupled circuit curve (a) followed by the ordinary transformer (b) gives the overall curve (b) on the right. The two valleys need not be more than 3db. down on the response at the peaks.

This much is useful to know, but still does not get us very far unless we can predict from the circuit values what the value of *k* is. In the bottom-capacity coupling circuit that we are using, this is also very easy. Referring back again to Fig. 1, we have (from the theory textbooks) that $k = C_1/C_3$. Thus, if we want *k* to equal 0.01, for instance, we know that C_3 must be 100 times C_1. As mentioned earlier, we can regard C_1 as the capacity needed to tune L_1, so that if we are using permeability-tuned coils which need a fixed capacity of 100 $\mu\mu$f. to tune them, C_1 will be 100 $\mu\mu$f., and C_3 will be $100 \times 100 = 10{,}000$ $\mu\mu$f. $= 0.01$ μf. Again, if we want a coupling factor of 0.05 for the broad position, we have, from the above formula, that $0.05 = 100/C_3$, or $C_3 = 2000$ $\mu\mu$f, or 0.002 μf.

Now, referring to Fig. 2, where the 100 $\mu\mu$f. condensers are shown, all we have to do to complete the job of finding the values of C_1 and C_2 is to find values for these condensers which make $C_3 = 0.01$ μf. (which is easy) and C_1 in series with C_2 equal to 0.002. We then have the values for the complete system.

A PRACTICAL CIRCUIT

At this stage, no doubt, many readers will say that this is all very nice, but the circuits of Fig. 1 and Fig. 2 do not in the least resemble a practical circuit for doing anything, and how do we modify the theoretical circuits to include the amplifying valves? Well this is also very easy. In Fig. 4 we have the practical version of Fig. 2. One coil is placed in series with the plate of the mixer valve, just as if it were the primary of an ordinary I.F. transformer. The network of condensers, however, is connected to earth, as in the theoretical diagram.

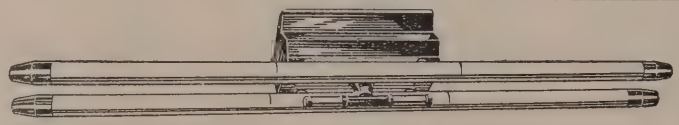
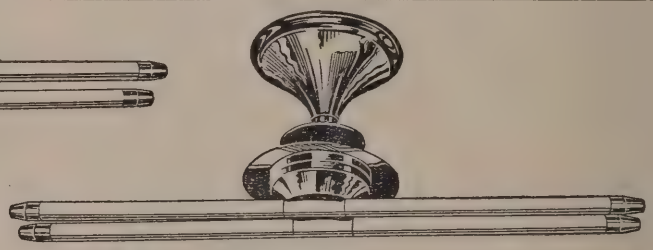
This may seem peculiar to some, because it is usual to see the tuning condenser or condensers associated with a coil connected directly across it. The effect is the same, however, because the end of the coil that goes to H.T. plus is also effectively earthed, as far as signals are concerned. This is because the H.T. line has an electrolytic smoothing condenser connected to earth, and this condenser is as good as a short circuit for signal frequencies, either R.F., I.F., or audio. Thus, the connection of the tuning condenser system to earth *does* place it effectively across the coil. The second coil is connected, as usual, in series with the grid circuit of the next valve, the I.F. amplifier. The lower end is bypassed to earth, just as is the secondary of an ordinary I.F. transformer, and then connected to the A.V.C. line. The 100 $\mu\mu$f. tuning condensers thus act also as blocking. condensers, preventing the H.T. voltage from being applied to the grid of the I.F. amplifier, and also isolating the coupling condensers and the selectivity switch from H.T.

In Fig. 4 we have not shown bias resistors, or the screen-grid voltage supplies to the valves, because these do not concern the coupling system at all, and can take any of the usual arrangements. The figures for the condensers suit a coil with a Q of 100, which is probably quite near the mark for most of the coils found in conventional I.F. transformers, when installed in a circuit.

SUPPLY OF COMPONENTS

One thing that will concern most of those who may wish to put the present idea into practice is the supply of suitable coils and condensers. This need not cause much difficulty, because it is a simple matter to take an ordinary permeability-tuned I.F. transformer and separate the two windings, using them for the two coils. The easier type to use is that in which the coils are mounted separately, together with their tuning slugs. In this case, it is only necessary to remove one of the coils, and mount it in a separate shield can. There is no need to shield the switch and the large condensers, since only a low I.F. voltage appears in this part of the circuit, which has a very low impedance. If constructors do not wish to do this, any manufacturer of coils should be apply to supply individually mounted single I.F. coils in shield cans, particularly if reference is made to this article.

As was mentioned above, the exact values of the condensers, other than the 100 $\mu\mu$f. ones, is not very critical. If 5 per cent. tolerance condensers can be obtained, these will do very well, but if not, the constructor can choose condensers quite well for himself if he has an A.C. voltmeter, or multimeter with A.C. reading. The idea is that it is much more important for the condensers C_1 to be equal than for their value to conform strictly to 0.002 μf. The exact value of the 0.01 μfd. condenser is not critical, and an ordinary 0.01 μf. mica condenser will be quite accurate enough. In order to check the 0.002 μf. condensers for equality, all that needs to be done is to connect them in series with an A.C. source and the A.C. voltmeter. The range does not matter, as long as a reasonably large reading is obtained. The 230v.

Show your customers what Zontilier can do!

NOW AVAILABLE IN 36 MODERN DISTINCTIVE DESIGNS SUITABLE FOR EVERY PURPOSE, IN HOME, SHOPS, BUSINESS PREMISES and INDUSTRY

Whenever you have inquiries for Fluorescent Lighting—demonstrate the adaptability of ZONTILIER. Undoubtedly the finest units on the market today, Zontilier Fluorescent Assemblies are available in a wide range of attractive and serviceable designs, sufficient to satisfy every fluorescent lighting requirement. Keep in step with current selected advertising. Make sure you have ample stocks of Zontilier Fluorescent Assemblies and the attractive brochure for distribution to the public.

Zontilier

FLUORESCENT LIGHTING CO., LTD.

188 WILLIS STREET :: :: WELLINGTON
Phone 51-798 P.O. Box 5030

2

mains can be used, or the output of one winding of a power transformer. Too high a voltage should not be used for a start, as this might give more than full-scale deflection of the meter even on the highest voltage range available.

Condensers are tied into the test circuit one after the other, and the readings for each noted, until two are found that give the same reading. These will then be matched to quite a close tolerance.

FINAL POINTERS ABOUT THE TWO-POINT SYSTEM

We have already mentioned the fact that at high degrees of over-coupling, the response curve of the transformer has a pronounced dip in the centre. This would cause the set to have lower sensitivity than may be necessary on the broad position, and would give the audio output a distinct rise at high frequencies, instead of a flat response. It is therefore necessary to fill up the hole, and the present paragraph shows how this is to be done. The practical circuit does not show the complete I.F. circuit of a set using the variable selectivity scheme described, because except for a very slight addition, in the shape of one resistor, it can be perfectly conventional in all respects. The I.F. amplifier will thus have a second transformer in its plate circuit, the secondary feeding the diode detector in the usual way. This transformer will have about the same selectivity as the windings used in the first "transformer," and will thus be much sharper than the former when it is in the broad position. It will also be tuned to the centre frequency, and when the selectivity switch is operated, its selectivity will not be affected. Therefore, it will have a peaked response, just where the first "transformer" has its dip, and the result will be that the second transformer tends to fill up this gap, making the overall selectivity curve undulating at the top, but flat within 2 or 3db. if the compensation is correct. Theoretically, to fill the gap properly, a single tuned circuit is needed, with a Q equal to half that of the windings of the first transformer. In practice, we can use a double-wound transformer—because this makes the detector circuit a conventional one—and keep it from being too selective by loading its windings a little with resistors. The secondary is loaded in any case, by the addition of the diode load resistor, which has to be there anyway, so that by making the load resistor, say 250k., instead of the more usual half or one megohm, and putting approximately 100k. across the primary, the whole second transformer will have almost the same selectivity as a single winding with a Q of 50. If the builder should be lucky enough to have a wobbulator, the exact effect of various degrees of loading on the windings of the second transformer can be visually observed.

ADJUSTMENT OF THE SET

When a set has been built with an I.F. channel of this sort, it is necessary to align it, of course, but luckily, this is no more difficult than aligning a simple set. All that has to be remembered is that alignment *must* be done with the selectivity switch in the narrow position. The set is then exactly similar to a conventional one, and all I.F. windings are aligned for maximum response on

(Continued on Page 45.)

DUPLICATE FACTORY PERFORMANCE!

SPECIFICATIONS:

Model CABC sub-assembly incorporates 3-band coil unit, 3-gang condenser, complete spinner-tune 5-colour dial with cord ready fitted, R.F. chassis section with R.F. and mixer sockets. Complete with trimmers, padder, by-passes, etc., and all rigidly pre-wired with exception of socket contacts. Full cadmium plated shielding. Suits either English or American valves.

DIAL: New and different—of unusually striking appearance, black background, gold and scarlet trim, and translucent peach panels. Broadcast and Band 1 Calibrations and black on clear glass with white backplate. Escutcheon included.

COVERAGE: (1) Broadcast Band; (2) 3.2 to 9 mc/s; (3) 9 to 24 mc/s.

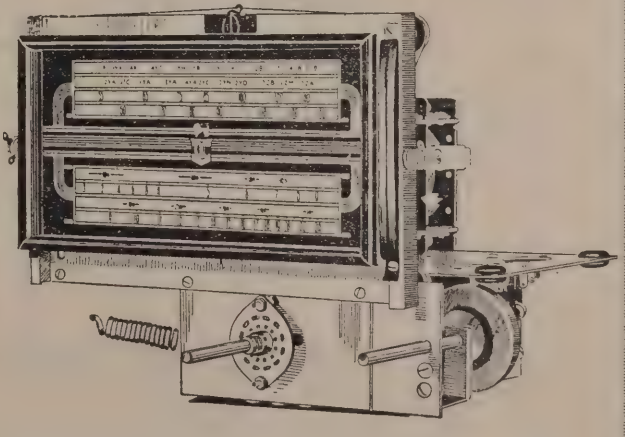
COMPANION Chassis, Cabinet, and Midget-super I.F.'s to suit this sub-assembly. Ask your dealer for price list, or write direct to—

JOHNS LIMITED.

JOHNS BUILDINGS, (P.O. BOX 471)
AUCKLAND.

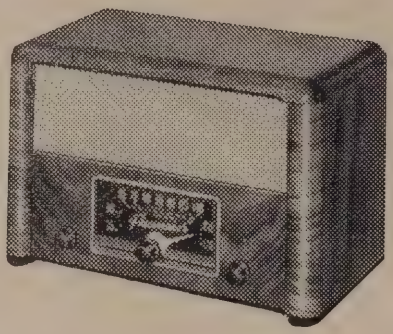
Radio set construction, to factory standards, becomes possible with this pre-wired and air-tested assembly.

DEFINITELY NOT A BAND-SPREAD UNIT and gives GENUINE ALL-WAVE COVERAGE RIGHT DOWN TO 13 METRES.



PACEMAKER

Five Valve Vibrator Mantel



Retail Price £30-10-0

Set Type — Vibrator Battery Superheterodyne

Tubes — 1T4 R.F. amp., 1R5 Converter, 1T4 I.F. amp., 1S5 Det.-A.F., 3Q4 Power Output.

Power Supply — Battery, 6 volts, .75 amps.

Tuning Range — Broadcast, 535-1700 kc.

Cabinet — Walnut Veneer.

Distributed by

H. W. CLARKE LIMITED

AUCKLAND - - WELLINGTON - - CHRISTCHURCH - - DUNEDIN

Laminations in Electrical Steel

for—

Manufacturers of Radios
Fluorescent Lighting, and
Electric Motors and Generators

•

A wide range of standard types is available for early delivery in—

STANTRANIS	1	0.74 watts loss per lb.	at 10,000 gausses and 50 cycles in 0.020" material
STANTRANIS	B	1.02 watts loss per lb.	
MEDRIS	.....	1.30 watts loss per lb.	
STANDYNIS	.....	1.52 watts loss per lb.	

Send your inquiries to—

JOSEPH NATHAN and CO. (N.Z.) LTD.

P.O. BOX 1509, WELLINGTON P.O. BOX 949, AUCKLAND

Made in England by G. L. Scott & Co., Ltd., Ellesmere Port, Cheshire.

PUBLICATIONS RECEIVED

Facsimile, by Lee Hills and Timothy J. Sullivan. Publishers: Messrs. McGraw-Hill Book Co., Inc.

Anyone who may still have doubts, either that the commercial exploitation of electronic developments has reached a state where startling applications will be few and far between, or that our American friends are the world's greatest commercial innovators, should read *Facsimile.* Properly speaking, it is not a technical volume —at least, not from the radio man's point of view— since it is really an exposition of the present state of development in the United States of commercial facsimile transmission. The authors are not concerned with explaining what goes on inside the transmitting and receiving apparatus, but rather with what can be done in the way of providing facsimile services, with special reference to the publication of a facsimile newspaper.

It may come as something of a shock to many readers in this part of the world that such a thing as a facsimile newspaper exists on a commercial scale, but such is the case. Various facsimile systems had been tried as the basis of such a scheme first, in the 1920's, and later in the 1930's. It was not until 1946, however, that a system that produced an acceptable standard of definition, together with a fast enough rate of reproduction was developed, mainly as a result of war-time facsimile development and its use in the armed services for the speedy transmission of maps and messages. The other chief factor making facsimile an acceptable medium for reproduction of news in the home was the development of the F.M. broadcasting. Pre-war attempts had used the normal broadcast band, and had employed audio frequency signals for conveying the intelligence. Transmission could thus be done only after normal broadcasting hours, on account of the highly disturbing nature of the sound of facsimile transmissions when heard through a loudspeaker. Another major difficulty with broadcast frequencies was the effect of fading and interference. The use of the F.M. broadcast channels has removed the above objections almost completely. In fact, to such a pitch has facsimile technique developed that in 1947, successful demonstrations were given of transmission and reception in full colour. Further development along the lines of television technique has resulted in the R.C.A. "Ultrafax" system, capable of remarkably high speed of operation.

As well as telling in an entertaining manner the story of the development of commercial facsimile transmission, the authors occupy much of their space with a description of the production side, which has closer affinities to the production of a newspaper than to either radio broadcasting on the one hand, or television on the other. This section is particularly well illustrated by numerous line and half-tone examples of the kind of material presented in existing organizations, and also of complete facsimile sheets, which are laid out rather on the style of the more pictorial kind of daily paper. Needless to say, advertising plays its part in the economics of facsimile, and this side of the business is discussed, as well as are methods of capitalizing on facsimile transmission, apart from the subscriber type of home newspaper service which forms the basis for much of the book's material.

For those who wish to keep abreast of the latest commercial applications of electronics, this book should be an interesting and valuable addition to the literature.

* * *

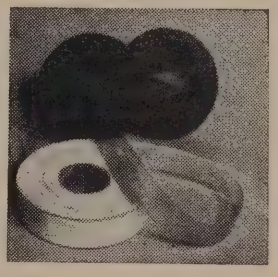
Fundamentals of Radio-Valve Technique, by J. Deketh. Publishers: Messrs. Philips Industries, Eindhoven, Holland.

The purpose of this book, according to the author, is "to give engineers and technicians not specialized in radio and allied techniques an impression of the construction and functioning of radio valves and their application in receiving sets and other electronic applications. It is hoped, however, that those who may have already considerable experience in electronic techniques may also find this book useful as a reference work."

The first four chapters deal in an elementary way, but very clearly and with suitable illustrative diagrams and formulae, with the fundamental physical basis on which the radio valve rests. The action of electrons in electrostatic and magnetic fields, potential distribution, electron emission from metals and specially prepared surfaces, the work functions of emissive materials, the space charge, and contact potential, are all dealt with. The next three chapters describe the component parts of practical radio valves, the construction of the valve as a whole, and their manufacture, respectively. In this section will be found much material that does not appear in the ordinary text-book, and the information is especially valuable in that the latest techniques are described, such as are used in the manufacture of metal of "Rimlock" valves.

At this stage (*i.e.,* at page 100 in a book of somewhat more than 500 pages) the text takes on more the appearance of a number of other books on the application of valves to radio receiving circuits. However, as well as dealing with the usual topics such as the various classes of amplifier, oscillators, detection, and frequency changing, the text covers a number of special circuit arrangements developed in the Philips laboratories, and in general, delves comparatively deeply into such matters as modulation distortion in radio frequency circuits, and the lesser-known effects of the different types of negative feedback, which find only scant reference in many text-books. A particularly valuable chapter in this respect is that dealing with the various kinds of hum, and in particular, we might mention that figures are given

(Continued on Page 45.)



High Class Insulating Cloths and Tapes

IOCO Limited produce insulating cloths and tapes for all purposes, including varnished glass of especially high non-conductivity.

A product of—

IOCO LIMITED

Anniesland, Glasgow

CORY-WRIGHT & SALMON LTD.

AUCKLAND WELLINGTON DUNEDIN

Full Stocks Available All Branches

The *Radio and Electronics* Abstract Service

ANTENNAE AND TRANSMISSION LINES:

A method of operating break-in with the same antenna for transmitting and receiving. The apparatus may be used on several bands with kilowatt transmitters.
—*QST* (U.S.A.), November, 1949, p. 18.

The use of the balanced "Twinax" line for the transmission of power from a balanced push-pull or symetrical source. The line is a form of transmission line which has two inner conductors instead of a central and outer conductor as in the conventional coaxial line.
—*Electrical Communications* (U.S.A.), September, 1949, p. 201.

AUDIO EQUIPMENT AND DESIGN:

A brief survey of that branch of acoustics, termed "ultrasonics," is given, with the history, application, and bibliography.
—*Electronic Engineering* (Eng.), November, 1949, p. 422.

How to obtain the best results from the installation of a high-fidelity speaker and to avoid disappointing results. The construction of a voice coil top-cut filter is described.
—*Radio and Hobbies* (Aust.), January, 1950, p. 36.

An amplifier patterned after the well-known "Williamson" circuit employing 807's for output is described in detail.
—*Audio Engineering* (U.S.A.), November, 1949, p. 11.

A description is given of a simplified pre-amplifier design—a plug-in unit which is interchangeable, with crystal equalizers and independent shielding.
—*Audio Engineering* (U.S.A.), November, 1949, p. 16.

In relation to the testing of amplifier design and performance, the effectiveness of the audio frequency measurements and other tests all depend on the measuring procedures employed. The methods are discussed and reasons given for every step.
—*Audio Engineering* (U.S.A.), November, 1949, p. 18.

MATERIALS AND SUBSIDIARY TECHNIQUES

Resistors for "deposited circuit techniques" are discussed, methods of making and materials for deposited film resistors, and their use and possibilities.
—*Electronic Engineering* (Eng.), November, 1949, p. 403.

MATHEMATICS

Contour analysis of mixer valves, the characteristics of which are completely defined by a series of three-dimensional surfaces. Two co-ordinates, grid voltage, and hetrodyne oscillator voltage determine the operating conditions for small signals.
—*Wireless Engineer* (Eng.), November, 1949, p. 350.

Design equations for servo-mechanisms—a classification and the mathematics involved in the design of the machines.
—*Electrical Communications* (U.S.A.), September, 1949, p. 249.

The methods of signal-to-noise ratio improvement in a pulse-count modulation system are discussed, with the mathematics involved.
—*Electrical Communications* (U.S.A.), September, 1949, p. 249.

Impedance calculations for transformers are encountered regularly in audio work. The method of making such calculations is simply explained.
—*Audio Engineering* (U.S.A.), November, 1949, p. 20.

A study is made of pulse frequency modulation in pulse communication.
—Proceedings of the I.R.E. (U.S.A.), November, 1949, p. 1277.

Data is given to assist computing the various winding capacitances of multi-layer windings used in the construction of audio-frequency transformers, chokes, and other equipment. Computing charts are supplied.
—*Electronic Engineering* (Eng.), November, 1949, p. 417.

MEASUREMENTS AND TEST GEAR

An instrument for measuring the power delivered to an antenna at communication frequencies is described.
—Proceedings of the I.R.E. (U.S.A.), November, 1949, p. 1245.

An optical Michelson interferometer is modified by replacing one of its branches by a directional coupler and waveguide. The instrument served for precision wavelength determination, measurement of dielectric constant, etc.
—Proceedings of the I.R.E. (U.S.A.), November, 1949, p. 1242.

A valve tester which will display a family of valve characteristics whereon one can investigate rapidly the effect of variation of a parameter by adjustment of controls is described.
—*Electronic Engineering* (Eng.), November, 1949, p. 425.

MICROWAVE TECHNIQUES

The citizens' wavemeter is described. Two co-axial type wavemeters are explained in detail for the guidance of experimenters in the 460–470 mc. band.
—*Electronics* (U.S.A.), September, 1949, p. 88.

RECEPTION-RECEIVERS

A single-sideband exciter that uses one of the preadjusted audio phase shift networks which are now available on the market. This removes the difficulty of adjusting the unit in which the audio network has been one of the stumbling blocks.
—*QST* (U.S.A.), November, 1949, p. 40.

TELEVISION

A summary is given of methods of obtaining sweep voltages for panoramic receivers by various means—double superhet, vibrating sweep system, klystron superhet, motor-driven oscillator, motor-driven potentiometer, phototube-triggered sweep, magnetically triggered sweep, detector triggered swep, motor-driven commutator, photoelectric sweep generator, clipped wave sweep generator, and sweeping I.F. amplifier.
—*Electronics* (U.S.A.), November, 1949, p. 111.

TRANSMITTERS AND TRANSMITTING

The problem of economizing ether space in relation to phase-modulated transmitters, which are vulnerable to over-modulation. The audio signal of a F.M. transmitter is differentiated, clipped and integrated so that the output wave is identical with the input except for slope limiting.
—*Electronics* (U.S.A.), September, 1949, p. 97.

The theory of operation of a phase shift type of oscillator is discussed briefly. The oscillator consists of a broad-band amplifier the output of which is fed back to input through a phase shifting circuit. True F.M. is obtained by this method.
—Proceedings of the I.R.E. (U.S.A.), November, 1949, p. 1328.

Means are described of harmonic suppression in amateur transmitters to avoid interference with TV receivers. The factors involved and a description of the rig.
—*QST* (U.S.A.), November, 1949, p. 21.

Pulse modulation, its history and application especially to time division multi-channel systems.
—*Electrical Communications* (U.S.A.), September, 1949, p. 222.

MISCELLANEOUS

Metal detector for the lumber industry. A new bridge-coil unit for the detection of metal in logs. Complete circuit diagrams are included.
—*Electronics* (U.S.A.), September, 1949, p. 100.

Potted assemblies for subminiature equipment. The capsulation of amplifier and oscillator sub-assemblies in casting resin has many advantages.
—*Electronics* (U.S.A.), September, 1949, p. 104.

Studies of the iron-oil mixture used in electromagnetic clutches reveal that the fluid can be used to good advantage in hydraulic systems, shock absorbers, casting moulds and variable electric resistors.
—*Electronics* (U.S.A.), September, 1949, p. 120.

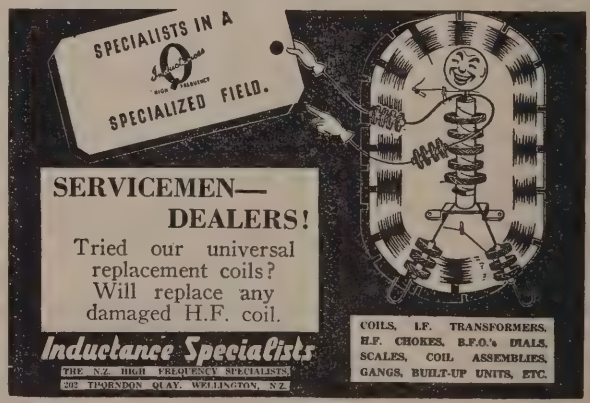
Electronic devices at work: Automatic machine for weighing livestock; a tunable built-in TV antenna comprising dipoles made of metal foils; an infra-red image converter tube now available in quantity and designed as a military weapon for seing in the dark; a robot race starter is described providing warning and starting signals for the runners and giving an indication of false start.
—*Electronics* (U.S.A.), November, 1949, p. 116.

A distance measuring equipment (DME) providing automatic distance indications for aircraft navigation is described, by the interrogation and reply system. Channeling methods on 100 channels is available.
—Proceedings of the I.R.E. (U.S.A.), November, 1949, p. 1236.

The magnetic fluid clutch in servo applications. The clutch employs iron disc rotors running in oil and powdered iron mixture that solidifies when the magnetic field is applied. The conditions under which the clutch may usefully be used are defined.
—*Electronics* (U.S.A.), November, 1949, p. 100.

An inductive prompting system for actors provides a simple type of receiver that can be worn inconspicuously on the actor. An inductive rather than a space system is used, and the receiver is in the form of a loop worn around the neck. The transmitter is coupled to an impedance of a single loop around the set.
—*Electronics* (U.S.A.), November, 1949, p. 100.

Hole injection in germanium transistors and quantative studies of filamentary transistors—the interaction of holes and electrons in semi-conductors. A study of transistor action from the theoretical viewpoint.
—*The Bell System Technical Journal* (U.S.A.), July, 1949, p. 344.


SPECIALISTS IN A
SPECIALIZED FIELD.
SERVICEMEN—
DEALERS!
Tried our universal replacement coils? Will replace any damaged H.F. coil.
Inductance Specialists
THE N.Z. HIGH FREQUENCY SPECIALISTS
202 THORNDON QUAY, WELLINGTON, N.Z.
COILS, I.F. TRANSFORMERS, H.F. CHOKES, B.F.O.'s DIALS, SCALES, COIL ASSEMBLIES, GANGS, BUILT-UP UNITS, ETC.

Rule out "half-measures" in Radio Servicing

★ A MARCONI ACHIEVEMENT
★ 3 INSTRUMENTS IN ONE
★ MAKES COMPLETE TESTS
★ DIRECTLY CALIBRATED
★ COMPACT AND PORTABLE
★ ACCURATE AND RELIABLE
★ FOR RADIO & TELEVISION
★ FROM MAINS OR BATTERIES
★ GUARANTEES YOUR WORK

PORTABLE RECEIVER TESTER TYPE TF888

depend on

MARCONI & MEASURTEST

***NOT JUST** another Signal Generator but a post-war development which enables lining up and measurements to be made of sensitivity, selectivity, second channel, suppression, A.V.C. operation, signal to noise ratio, hum level and power handling capacity of receivers covering communication, broadcast, amateur, and television bands. Range 70 kc/s. to 70 mc/s.*

OTHER INSTRUMENTS OF MEASURTEST RANGE (MAINS OR BATTERY)

VALVE VOLTMETER TF887

Ranges and Facilities:

A.C. Volts: 0–125v. in 3 ranges, 20 c/s. to 300 mc/s., or up to 500v. with multiplier.

D.C. Volts: 0–250v. in 4 ranges, or up to 1000v. with multiplier and up to 5000v. with high-voltage probe.

Resistance: Up to 2 megohms in 3 ranges.

AUDIO TESTER TF894

Ranges and Facilities:

Frequency: 50 c/s. to 12 kc/s.

Output: Continuously variable up to 300 mW. into 600 or 5000 ohms (13.4v. and 38.8v.).

Attenuator: 0–50 db.; 600 ohms

Voltmeter: 0–80v. in 4 ranges, 50 c/s. to 12 kc/s.

Power Supply: 200–250v., 40–100 c/s.

VALVE MILLIVOLTMETER TF899

Ranges and Facilities:

Voltage: 0–150, 0–500, and 0–2000 mV in the range 50 c/s. to 100 mc/s.

Input Conditions: Resistance greater than 1 megohm at 1 mc/s. Capacitance approximately 7 mmf.

Power Supply: 200–250v., 40–100 c/s.

Complete technical information available on request from:

AMALGAMATED WIRELESS (A/sia) LTD.
P.O. BOX 830 WELLINGTON

A Wide-Band Amplifier for Oscilloscopes

A circuit is described which has a frequency response useful up to 4.5 mc/sec. It gives balanced, or push-pull output from an unbalanced input voltage, and apart from the five valves used does not contain a great many components. It is very well suited to the examination of square-waves and other irregular wave-forms which require a wide frequency response for proper display on a C.R.T., and is capable of filling the screen of a five-inch tube from an input of 1v. R.M.S.

INTRODUCTION

Many times have we been asked if we could recommend circuits for wide-band amplifiers. The inquirer usually turned out to be one who had come into possession of an inexpensive war-surplus cathode ray tube, and who, on reading the specifications of some of the better commercial oscilloscopes, had decided that nothing would do but a circuit which would enable his home-built 'scope to duplicate commercial performance. Most often, it would be found on inquiry that the person concerned had had little or no experience in building an oscilloscope of any sort, let alone one with the most difficult requirements to fulfil. Also, the bulk of the work that is done with the oscilloscope can be perfectly well carried out by an amplifier whose response is, say, 3db. down at 60 to 100 kc/sec. Such an amplifier can be built using ordinary resistance-coupled amplifier technique, and small receiving valves, with low current drain, and inexpensive construction.

Amplifier circuits of this nature are well within the scope of the amateur to build, although even here, certain of the requirements are considerably more stringent than they would be in an ordinary audio amplifier. For one thing, hum must be kept to a much lower level in a 'scope amplifier than in an audio amplifier, because hum that would be quite inaudible in the latter would be annoyingly visible in the former.

Briefly, then, a complete oscilloscope, using wide-band amplifier technique throughout is definitely NOT the cup of tea of a beginner to 'scope work, however experienced he may be in other branches of electronics.

Then there is the expense angle. While it is theoretically simple enough to design a wide-band amplifier, putting the paper design into practice is apt to be more expensive than might appear at first. If only small output voltages are wanted, then small tubes with low operating currents will do the job, but when high output voltage as well as wide frequency response is needed, as in a 'scope amplifier, the power supply requirements become such that one decides to build as few of them as possible! This is not intended to put anyone off building the present amplifier, especially if he has a suitable power supply that can be used, but it should be realized that the whole amplifier draws approximately 150 ma. at 300 volts. A 'scope, which might well use two such amplifiers, then becomes a little expensive, purely for the pleasure of extending the top frequency response from, say, 50 kc/sec. (which is any amount for ordinary testing of audio equipment) to 4.5 mc/sec.

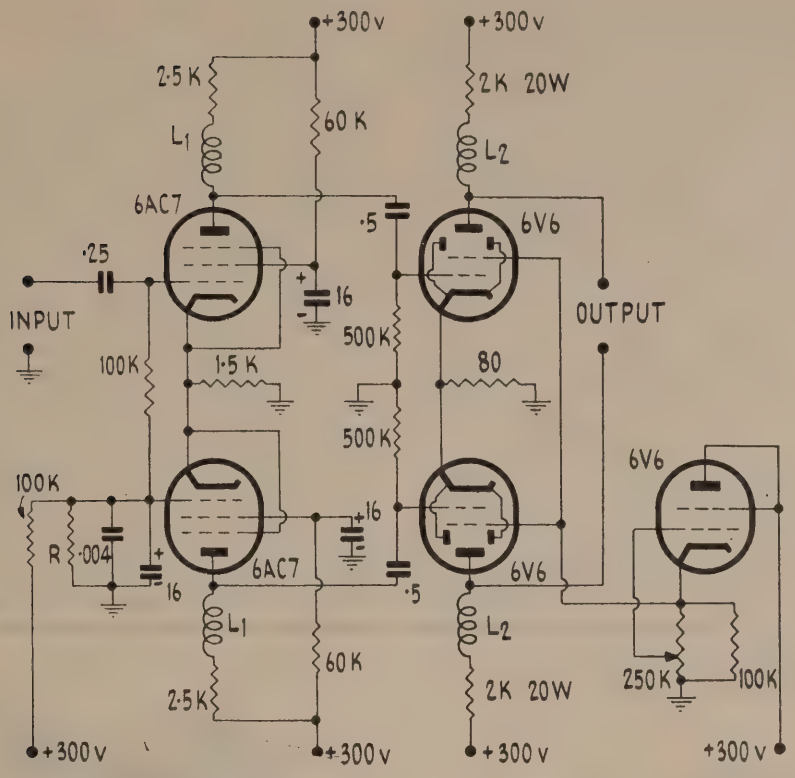
In our own laboratory, the bulk of our work does not take us to frequencies higher than an ordinary 'scope amplifier will handle, so that when we considered providing ourselves with a good oscilloscope, it was decided that a *good* amplifier circuit, with response flat to 40 or 50 kc/sec. would be quite effective enough, and quite expensive enough, too, for a start. The resulting instrument has already been described in *Radio and Electronics* under the title of "An Oscilloscope Employing Unit Construction," and appeared in a series of articles commencing in the November 1948 issue. This is still giving sterling service, and because of its flexibility, it is possible to build separate amplifiers for special purposes, and use them in conjunction with the original tube unit. Where this sort of construction has been followed, the most inexpensive way of extending the frequency response is to build a separate wide-band amplifier, which simply becomes another unit. A single amplifier for the Y axis is sufficient for many purposes, but if at a later date it is decided that an identical wide-band amplifier would be an advantage for the X axis as well, this can be provided just by duplicating the original amplifier. Building piecemeal like this is far less strain on the pocket than trying to construct something with all possible facilities at the start. It is also liable to result in a complete system which works much better, since each unit is individually built, and can be adjusted individually for best performance, regardless of other parts of the whole set-up.

The purpose of the present amplifier is therefore to provide extra facilities for a 'scope which is already excellent as far as it goes, and which will definitely go further once the new unit is built.

CIRCUIT DESIGN

In attempting something new, it is often a good plan to omit some of the features which are perhaps difficult to insert, and which do not confer fundamental advantages that cannot be done without. In the present case, the main emphasis is on producing an amplifier which will have a flat response from low audio frequencies to very high ones (for an untuned amplifier) so that most of our effort must be directed towards this end. Anything that might be desirable, but which would partly vitiate our efforts in this direction, is better omitted altogether. Thus, it will be noted that nowhere in the amplifier is there an ordinary gain control, which while very desirable from the point of view of being able to adjust the size of the picture readily, does not allow the frequency response to remain the same at different settings. It has been left out, therefore, and instead a compensated voltage divider giving fixed steps of attenuation has been installed. This enables large input voltages to be handled, and if the steps give no more attenuation than four times greater than the previous one, a continuously variable control becomes unnecessary, since a variation in picture height of four to one can easily be tolerated. The attenuator has not been included on the main circuit diagram. Instead, we would refer readers to an article that appeared a few months ago in these pages. It described the principle and adjustment of compensated voltage dividers, which give a fixed degree of attenuation without any effect on the frequency response. The article referred to was entitled "A Three Step Frequency-Compensated Attenuator for Use with Oscilloscopes," and was published in the October 1949 issue.

The circuit for the attenuator, which had three steps, giving attenuations of 2, 11, and 111 times, is given in the article, but enough information is also given for the builder to design his own voltage dividers. If these are made to give attenuations of four, sixteen, 64, and 256 times, a five-position, two pole switch will be needed, and no continuously variable control will be wanted, for in-



puts ranging from 0.25 volts to 256 volts R.M.S. The attenuation steps are so arranged that any input voltage between these limits will give a picture on a 5 in. C.R.T. that is between 1 in. and 4 in. in height. At all positions of the switch the frequency response will be the same, and no mental reservations have to be made that the picture on the screen is not just what it should be, owing to the position of the "volume control."

Having got that bit off our chest, as it were, we can now proceed to the amplifier proper. This consists of two stages. The first uses 6AC7's, and as well as giving useful amplification, acts also as a phase inverter, giving balanced outputs to feed the grids of the push-pull 6V6's in the second stage. The system of phase inversion used is commonly known as the cathode-coupled circuit, and in its original form (which employed triodes) was described fully in O. S. Puckle's book *Time-Bases*. Here, pentodes are used, and the only variation from the original circuit, apart from the use of suitable values for pentode valves is the addition of the screen voltage dropping resistors and their bypass condensers. A glance at the circuit shows that apart from the addition of the compensating inductors L_1 and L_2, it is to all intents and purposes identical in appearance with the voltage amplifier stages of an audio amplifier with resistance-capacity coupling. However, even without the inductors, the values used show decided differences between this and ordinary audio practice. The load resistors for the 6AC7's are only 2.5k. each, and those of the 6V6's are only 2k. each. It can be expected then, that the voltage gain per stage will not be nearly as high as in an audio amplifier. Similarly, the current drain of the 6V6's will be almost as great as when these valves are used as a push-pull output stage, because the load resistors are so small as to have no real effect on the plate current. To get some idea of the gain per stage, we can use the well-known formula $M = Gm.R_1$, where M is the stage gain, Gm is the mutual conductance of the valve, and R_1 is the load resistance. The valve data books quote a figure of 9.0 ma./v for the Gm of a 6AC7, and the load resistor is 2,500 ohms. The gain to be expected is therefore 22.5 times. This would normally apply to each half of the phase-inverter stage, but the cathode-coupled connection reduces the stage gain somewhat, so that a more likely figure would be 12 to 14 times, that is from the input grid to each 6AC7 plate. We can find the gain of the second stage in the same way. The Gm of the 6V6 is 3.75 ma./v., and the plate load in this stage is 2,000 ohms. The stage gain will therefore be approximately 7.5 times. This gives an overall gain for the two stages of 90 to 105 times. Since a 5BB1 cathode ray tube will ordinarily need approximately 110v. R.M.S. to fill the screen, the amplifier is capable of filling the screen if supplied with an input voltage of little more than 1v. R.M.S. An input of 0.25v R.M.S. will thus produce a deflection of one inch on the tube. This degree of sensitivity brings up some very interesting possibilities in the use of the 'scope with this amplifier for the testing of receivers. Except perhaps at the aerial terminal, it should be possible to connect the amplifier input to any part of a set and obtain a deflection on the screen which will give a direct indication of the signal amplitude at that point. Since the amplifier responds equally well to all frequencies up to approximately 4.0 mc/sec., a set handling radio frequencies up to this figure can be examined in this way, and we hope to give some interesting applications later in the article.

OBTAINING WIDE-BAND RESPONSE

The part of this amplifier that will be new to most builders is the way in which the frequency response is extended to such a high limit. In order to see how this is done, it is necessary to examine the ordinary resistance-coupled amplifier and see where its high-frequency performance falls down and why.

Although no capacitors are shown on the circuit other than the coupling ones, there are always unintentional and unavoidable ones present, in the shape of the internal tube capacities and the capacity of the wiring. For instance, the output capacity (*i.e.*, the capacity from plate to all other electrodes) of a 6AC7 is given as 5 $\mu\mu$f. and the input capacity as 11 μf. Suppose we had a plate load resistor of 100k. instead of the low one actually employed. This would cause two sources of high-frequency loss to become quite severe. The first of these would be the shunting effect of the output capacity on the load resistor. Unforunately, this would not in practice be restricted to the effect of the 5 $\mu\mu$f. attributable to the 6AC7. To its output capacity we must add the input capacity of the 6V6, which adds a further 10 $\mu\mu$f. Then we shall have to allow at least 5 $\mu\mu$f. for stray wiring capacity, making a total of at least 20 $\mu\mu$f. in shunt with the load resistor of the 6AC7. Now in estimating the effect of this capacity on the frequency response of the 6AC7 stage, we can apply the simple rule that *the response will be down 3db. at the frequency at which the reactance of the shunt capacity equals the value of the load resistor.* Thus, working out the formula

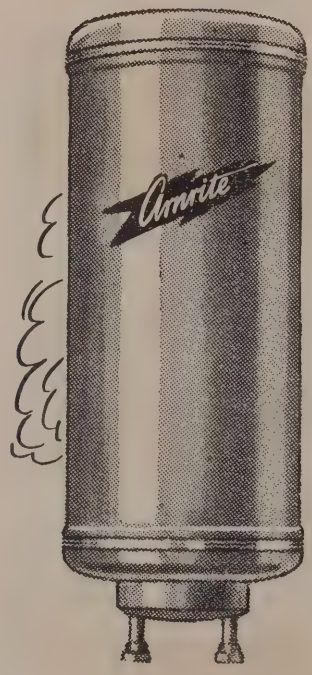
$$X_c = \frac{1}{2\pi f C},$$

By putting X_c equal to 100,000 ohms (for our illustration) and C equal to 20 $\mu\mu$f. we find that f, or the frequency for a 3db. drop in response is 85 kc/sec. This is reasonably high, but is nowhere nearly as high as we want. What then, can be done about it? We cannot vary the unavoidable shunt capacities, but the load resistor can be changed, within limits. If we make the load resistor much lower than 100k., the gain will go down in proportion, as the formula for the gain shows, but at the same time, the effect of the shunt capacities will be reduced, for they now find themselves across a lower resistance. For example, if we reduce the load to 10k., the frequency for 3db. drop is raised to 850 kc/sec. We now have something that looks a little more like a really wide-band amplifier. The point is, how far can we carry this process, and how far should we, having regard to our response requirements? The answer is that in order to widen the response, the load resistor can be reduced to the point where the gain is no longer great enough to be profitable. However, with a tube like the 6AC7, with its very high Gm, we can use a very small load resistor and still have a gain that is considerable. Using our previous calculation as a basis, we can see that if the load resistor is reduced to 1000 ohms, the gain will be 9 times, but the frequency for 3db. drop in response is

Announcing—

Arnrite

2 Gallon WATER HEATER



This smart, modern Water Heater fits neatly over the sink or basin . . . in the home, office, factory, club or consulting rooms.
Attractively finished in cream enamel with chrome bands. A quality water heater throughout. Fills automatically and heats to 185 degrees F. in quick time. *Fully guaranteed for 12 months.*

OBTAINABLE WITH OR WITHOUT FAST BOILING SWITCH

The 2-gallon Arnrite is procurable with or without a switch, which raises the water to boiling in 15 seconds.

• JUST PRESS THE SWITCH AND TURN THE TAP . . .

THIS 2 – GALLON ARNRITE CAN BE PURCHASED FOR ONLY £17 – 10 – 0

Other Arnrite Models are in 3, 6, and 10-gallon sizes. 3-gallon also has fast boiling switch.

STOCKED BY LEADING ELECTRICAL DEALERS

N.Z. Distributors: Arnold and Wright, Ltd., Auckland, Wellington, and Christchurch.

now up to 8.5 mc/sec.! This is higher than we had bargained on going with this amplifier, but it illustrates the possibilities for widening the pass-band in doing nothing but reduce the load resistor's value. However, there are other things that have to be considered, namely the stage gain, and also the greatest undistorted output that the valve will give with the reduced load. Both of these things make it necessary to use more stages to get a given overall amplification if the load reduction is carried too far. In practice, what we do is to choose the load resistor so that its value equals the reactance of the shunt capacity *at the frequency up to which we want the RESPONSE TO BE FLAT.* This means that if nothing more were done, the response would actually be 3db. down at this frequency, which is still not good enough. At this stage, however, we bring in the compensating inductor L_1, and the effect of this, when correctly proportioned, is to correct the droop and make the response actually flat up to the top frequency desired. Thus, in this amplifier, the load resistor of 2.5k. for the 6AC7's would give us a response 3db. down at approximately 3.4 mc/sec. Of course, these figures are only approximate, because our estimate of the shunt capacity could easily be 20 per cent. out one way or the other, which will put our calculations out similarly.

The main purpose of the numerical examples given above was to illustrate the principles used in designing a wide-band amplifier. A full description would take several issues of this magazine, and would hardly be in place in an article of this kind. However, we have said enough to show why low load resistors are necessary, together with their low stage gain and low undistorted output voltage. Also explained is the need for high-Gm valves in wide-band amplifiers. For if we attempt to use an ordinary pentode, such as a 6SK7, for instance, the Gm is low, but the capacities are almost the same as in the high Gm tube. The result is that by the time the load resistor has been reduced far enough to give the required frequency response, the stage gain has disappeared! So too has the available output voltage!

So far we have considered only the loss due to one set of shunt capacities. Unfortunately, another exists at the output of the 6V6 stage, so that it is necessary to have further inductive compensation in the plate circuit of the second stage. The output capacity of the 6V6's and the input capacity of the C.R.T. deflection plates must be considered here.

Since this is a constructional article rather than one on design, we will not go into the method of designing the compensating inductors, but will give the appropriate winding data. These chokes are simple single-layer coils wound on $\frac{3}{4}$ in. diameter formers, and present no constructional difficulties.

6V6 SCREEN FEED ARRANGEMENTS

In order to get sufficient undistorted output voltage from the 6V6 output stage to fill a 5 in. C.R.T., it is necessary to use a plate supply voltage of 300. This is too high for the screen-grids of these valves, so that some means of reducing the screen voltage to 250 is needed. The scheme used here is to employ a further 6V6 as an electronic voltage divider. The screens of the amplifier tubes can then be adjusted exactly to 250 volts. This done, it does not matter if the plate voltage is a little higher than 300, because it is the screen volt-

Turn off HIGH MACHINING COSTS

Whether the Part be Simple or Complicated

We have the equipment and organization to make it cheaper! The production of component pieces in quantity by high speed automatics is our forté—any part obtainable from bar stock up to $2\frac{1}{4}$ in. Round (Brass or Steel).

AUTO MACHINE MANUFACTURING Co LTD

Nos. 18–20 NELSON STREET - - - - AUCKLAND
P.O. Box 179 Telephones 31-638 (three lines) Telegrams: "Auto"

age that really determines for all practical purposes how much plate current the tubes will take.

ADJUSTMENT OF THE RESISTOR R

In the cathode-coupled phase inverter circuit, it will be noticed that as far as signals are concerned, the control grid of the lower 6AC7 is grounded by the bypass condensers from it to ground, and also is decoupled from the other 6AC7 grid by the 100k. grid resistor. Since there is a comparatively large cathode resistor, common to both tubes, the grid bias would be much too great except for the fact that the grids are given a direct positive bias which has the purpose of partially counteracting the negative bias given by the cathode resistor. This positive bias is obtained from a voltage divider connected to H.T. plus, consisting of R and a 100k. resistor. After the amplifier has been built, R is adjusted to make the 6AC7's draw a total of 25 ma. plate current. The bias is then correct, and variations between tubes when these are replaced will not have any appreciable effect on the performance. The reason for not specifying exactly the value of R is that it will depend on the leakage of the 16 μf. bypass condenser, and cannot be predicted. However, if a good electrolytic is used, its leakage will be small ,and will not change appreciably with age, and the initial value of R will not have to be changed.

CONSTRUCTION OF THE AMPLIFIER

The construction can follow normal audio amplifier practice to a large extent, but it should always be kept in mind that it will respond to quite high radio frequencies, and that feedback from the output to the input can cause R.F. oscillation just as in an R.F. amplifier. One thing that helps is that the circuit is a low-impedance one throughout, so that except at the plates of the 6V6's, not a great deal of signal voltage exists. One point that needs watching is that the chokes L_1 should be mounted a fair way from the chokes L_2, and should be placed with their axes mutually at right angles. This helps to prevent undesired coupling between them. Also, the input terminal should not be anywhere near the output, or indeed near the 6V6's at all, since several hundred volts appear at their plates, and such a high signal voltage can easily feed back by capacity coupling between the wiring. Also, if predictable performance is wanted, it is advisable to use a single earthing point for each valve, if not for each stage, since signal currents can easily feed back through unintentional inductive coupling, if they are forced to return through the chassis to the valves' cathodes. If these few words of wisdom are heeded, no one should have any difficulty in constructing the amplifier with every success.

APPLICATIONS

Apart from the obvious applications of such an amplifier to the examination of pulses, square-waves and other non-sinusoidal wave-shapes which need a wide-band amplifier for their proper display, there are a few interesting applications of an amplifier which will respond well into the radio frequency spectrum without any tuning. For instance, it should be possible to observe visually the R.F. output of a long, high aerial. The addition of a tuned circuit at the input terminal should enable individual signals to be selected and viewed on the screen of the C.R.T. without detection! It is clear that the amplifier could be attached to a receiver in such a way as to show either the envelope or the trapezoidal type of modulation pattern, allowing the modulation percentage of a distant station to be measured directly. Also, if careful measurements are made of the modulation patterns, it should be

Continued on Page 45.

New! VIBRATORS

by

WIMBLEDON ENGINEERING CO.

HIGH POWER • HEAVY DUTY

CONVERTERS (for 50-cycle output)
INVERTERS (synchronous rectifiers)
RANGE now covers 2 to 220 volts operation.

RATINGS from 20 to 440 watts

Means economical power supplies for high-powered amplifiers, transmitters, etc., portable, mobile, or marine services

RECOMMENDED FOR USE IN CARAVANS, HOME LIGHTING PLANTS, ETC.

Write to

INDUSTRIAL ELECTRONICS LTD.

P.O. BOX 1w :: :: AUCKLAND

AUTOCRAT CAR RADIOS

OUTSTANDING PERFORMANCE AND LEADERSHIP

AVAILABLE IN 6v. & 12v. MODELS

A FEW DEALERSHIPS STILL AVAILABLE FOR THIS EXCEPTIONAL CAR RADIO

•

ANTONE A.C./BATTERY PORTABLES

NEW IN EVERY RESPECT

CHOICE OF COLOURS

Retail Price, complete, only

19 GUINEAS

•

WRITE FOR DETAILS

SAMPLES CAN BE MADE AVAILABLE

Autocrat Distributors Ltd.

3rd Floor 20 Victoria Street

WELLINGTON

Distributors and Factory Representatives

AN AUTOMATIC WEATHER-REPORTING STATION

PART 2 - CALIBRATION CHARTS

Last month's issue of *Radio and Electronics* featured an article by Mr. G. J. Wood describing the action of an automatic weather-reporting station at present working in Wellington. The calibration charts referred to in that article are reproduced here for the benefit of those who may wish to make use of the transmissions in order to obtain the meteorological readings at Wellington. For details as to how the readings are obtained, and applied to the charts, readers are referred to page 4 of the February 1950 issue of *Radio and Electronics*. For those who have not yet seen that article, we may say that all that is needed in order to decipher the signals sent out by ZKA, the automatic transmitter, is a short-wave receiver and a stop-watch, or a watch with a second-hand. By means of simple counting operations, and the charts reproduced here, any of the transmitted information can be read. Transmission times are 6.15 a.m., 9.15 a.m., 3.15 p.m., and 9.15 p.m. The first four transmission are on 5475 kc/sec., and the last is on 3185 kc/sec.

The charts will be found on pages 30–32 inclusive.

Beacon Technical Topics No. 21

BEACON RADIO LTD.

UNIVERSAL LINE MATCHING TRANSFORMERS

Often it is necessary to use a number of loudspeakers spread over an area and working from a single amplifier. The loudspeakers may have different voice coil impedances and possibly differing power requirements. A "universal" line to voice coil transformer for each loudspeaker will allow almost any combination of loudspeakers to be matched into an audio frequency transmission line. Providing care is taken not to place too many transformer primary windings in parallel, the frequency response of a system using a number of universal transformers can be very good.

Supposing that several similar loudspeakers have to be matched to a 500-ohm line by using universal transformers, let us consider two typical cases. If, say, three speakers are in use, the three transformers could be placed directly across the line. In order to present an impedance of 500 ohms, each transformer primary would have to be matched so that the secondary load was reflected as a 1,500-ohm impedance. The three transformers in parallel would then present an impedance of 500 ohms to the line. Supposing four loudspeakers were to be used: then a series-parallel combination could be arranged. In this case, the secondary taps should be selected so that each primary impedance would become 500 ohms. The four transformers would then reflect a combined load of 500 ohms across the line, and each voice coil would receive one-quarter of the available audio power. By similar methods, other arrangements of loudspeakers could be made to match any audio frequency transmission line.

The distribution of power so that some speakers' voice coils receive more than others requires rather different treatment. Any person familiar with Ohm's Law and its application to impedances should be able to arrange the secondary taps so that each transformer presents the required impedance in order to obtain its correct share of power.

BEACON make standard inexpensive universal line to voice coil transformers and provide an impedance matching graph for facilitating the choice of secondary taps for any required primary impedance. The transformers have a split primary winding so that nominal primary impedances of 150 ohms and 600 ohms may be used with minimum insertion loss. The split primary winding also allows the transformer to be used across lines carrying D.C.. Physical dimensions of the transformer are the same as those of the familiar BEACON Universal output transformers. The following types are standard:—

Cat. No.	Nominal Rating	*Overall Dimensions
50 S 50	3-watt	2½ in. x 1¾ in. x 1½ in. high
50 S 51	6-watt	3⅛ in. x 2⅛ in. x 2 in. high
50 S 52	10-watt	3½ in. x 2⅜ in. x 2¼ in. high

*Includes mounting lugs

BEACON RADIO LIMITED

32 FANSHAWE STREET, AUCKLAND, C.1

MANUFACTURERS OF DRIVER AND MODULATION TRANSFORMERS, Etc.

If you are not served by one of the Wholesale Distributors mentioned below, please get in touch with us direct.

WELLINGTON
Green & Cooper Ltd.,
43 Lower Taranaki St.,
WELLINGTON

TARANAKI
J. B. MacEwan & Co., Ltd.,
King Street,
NEW PLYMOUTH

OTAGO
R. H. Gardner.
42 Crawford St.,
DUNEDIN

The PHILIPS Experimenter

No. 29: USING THE AERIAL COUPLER

Although a good deal of information seems to be published in the amateur literature on the subject of transmitter aerial matching, and how to obtain it, this is one of the subjects upon which a surprisingly great amount of confusion still exists. It has been felt, therefore, that some description of how the aerial coupler unit is used with the Philips transmitter may be of considerable use to readers, and at the same time may help to ensure that those who have built the transmitter will get results from it that are at least commensurate with its possibilities. It is proposed, then, to use this issue of the "Experimenter" to describe in full the adjustment of the aerial coupler and final amplifier, in one or two representative cases, which will cover the majority of requirements.

FEEDING A TWO-WIRE LINE

Referring again to Fig. 6, which has already been described very briefly, we see that it consists basically of a tuned circuit, L_1 C_1. This is so arranged physically that the link from the final amplifier, and also the line that goes to the aerial may be tapped directly on to the appropriate turns of L_1. Provision is made also for connecting either an extra condenser, C_2 or coil L_2, across the output line before it goes off to the aerial. THIS ARRANGEMENT IS SUITABLE FOR FEEDING ANY TWO-WIRE LINE, WHETHER "TUNED" OR "UNTUNED," and the procedure to be described will enable power to be fed to any two-wire line.

In feeding power from any transmitter to any aerial, there are really only two fundamental requirements. The first of these is that the aerial or aerial system shall be tuned to the operating frequency. The second, is that at the transmitter end, the feeders shall present to the final amplifier a load impedance of such a form and magnitude that the transmitter is able to deliver output power to the feeders. If both these requirements are fulfilled then the transmitter will deliver power to the feeder input terminals, and also, this power will be radiated by the aerial system. Now the first of these requirements can be satisfied simply by suitably constructing the aerial or aerial system. For example, if the aerial is to be a half-wave dipole, this first important condition is satisfied if the aerial is cut to the correct length. This having been done, it must be possible, by means of some suitable coupling arrangement, to make the aerial radiate power fed to it by the transmitter. If not, nothing we can do at the transmitter end of the feeder line will induce the aerial to radiate with maximum efficiency, and except in certain special cases, it will not be possible to load the transmitter in such a way that it delivers its full power output.

We will assume, therefore, that the aerial has been cut to its proper length for the frequency to be transmitted. At this stage, it is necessary to distinguish between what are usually called "tuned" and "untuned" feeders respectively. The former operate with standing waves on them, while the latter, ideally, have none. Untuned lines, therefore, have an input impedance consisting of a pure resistance, equal in value to their characteristic impedance. Tuned lines, on the other hand, may present a wide variety of input impedances, and these will, in general, take the form of a resistance shunted by a reactance, which may either be inductive or capacitative. Thus, in feeding the two kinds of line, the coupling unit has two different types of job to perform. In the case of the untuned line, all it has to do is to act as an impedance transformer, matching the resistive load needed by the final amplifier to the resistive load presented by the feeders. In the tuned case, however, the coupling unit has *in addition* to tune out the reactive part of the load impedance presented by the feeders, and introduce the load to the final amplifier as a pure resistance once more. As everyone knows, the ordinary method of feeding tuned feeders is to connect con-

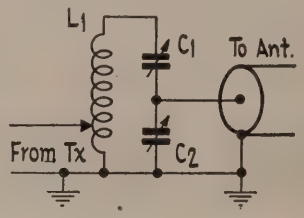


Fig. 5

densers either in series or parallel at the feed end, and use this capacity, together with the coupling coil, to tune out the line reactance. This system works very well, but it is necessary to know the range of feeder lengths over which series or parallel tuning is most suitable, if the best results are to be obtained. In the method about to be described, however, the reactance is tuned out simply by connecting either a capacity or an inductance in parallel with the input end of the line, as indicated in Fig. 6. Which is used in any particular instance simply depends upon whether the reactance to be tuned out is inductive or capacitative.

With this system, the case of an untuned line that does not match the aerial exactly merely becomes similar to that of the tuned line, in that some reactance appears at the input end of the line, and has to be tuned out by either C_2 or L_2, whichever is appropriate. Thus, the procedure in tuning up the aerial coupler becomes the same, irrespective of the type of line to be fed.

TUNING UP THE CIRCUIT OF FIG. 6

We will suppose for a start that we have a tuned line, attached to an aerial of the proper length for the transmitted frequency; we therefore set up the circuit of Fig. 6. L_1 we make identical in turns and inductance to the final amplifier tank coil for the frequency in use. C_1 we have already chosen as identical with the final tank tuning condenser. First, we attach the link which comes from the output of the final amplifier, to L_1. The wires are tapped a few turns (two or three) on either side of the centre-tap. Next, with the feeders disconnected, the transmitter is turned on, and the final tank circuit tuned to resonance. The swinging link is very loosely coupled, and C_1 is tuned through resonance. At resonance, a rise in the plate current of the final will be seen, and C_1 should be set right at the peak of the rise. It is most essential for the coupling to be very loose for this purpose, and only enough coupling should be used to enable a flick of the plate current meter to be observed. This done, the dial setting of C_1 is noted for future reference. Next, the feeders, without either C_2 or L_2 connected, are taped across a few turns of L_1 (in the first instance only a few more than are used for the input link). Since the line is reactive, the tuned circuit will no longer be on frequency, and C_1 will have to be adjusted to find resonance once more. To do this, the transmitter is turned on again, and C_1 adjusted as before.

The new setting of the C_1 dial is noted. If the second setting of C_1 is at less capacity than the first, the reactance of the line must be capacitative, for it has been necessary to reduce the amount of capacity to restore resonance. On the other hand, if the capacity has had to be increased, the line termination must be inductive, requiring extra capacity to counteract it. Incidentally, the purpose of tapping the feeders well down L_1 for this test is so that the reactance of the line will not have so much effect that the range of C_1 is unable to restore resonance, so that should this happen, it will only be necessary to tap the feeders closer still to the centre-tap. So far, then, we have found whether the feeder reactance is capacitative or inductive, and therefore whether C or L must be added in parallel to make them tune to frequency. Let us suppose that the feeders were inductive, and that C_1 had to be increased in order to restore resonance. In this case, we need extra capacity across the feeders to cancel their own reactance. We therefore connect in C_2, and proceed to the next adjustment. This is quite simple, and consists of finding how much capacity must be added by means of C_2 in order to allow C_1 to tune to the transmitter frequency at the setting found before the feeders were attached, *i.e.*, the first setting found. We therefore set C_2 to a likely value, and re-tune C_1, noting the new setting for resonance. This tells us whether we have used too much C_2 or too little, and by further trials in this way, we come to a point where with the feeders attached, the setting of C_1 for resonance is the same as without the feeders. Their reactance must

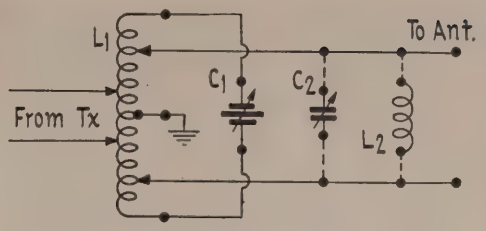


Fig. 6

therefore have been tuned out, and we can now proceed to arrive at the correct loading for the transmitter.

Since we now have everything tuned to frequency, *no further adjustments must be made to C_1, C_2, or the final's tank condenser.* First, the feeders are tapped out to about half-way on L_1. The coupling link is left across its few turns, as indicated on Fig. 6, and the swinging link on the final is coupled more closely to the final tank coil. If all has been faithfully carried out, as described, it should be possible to load the final up to full output simply by swinging the coupling link. If it should be found that even with the swinging link fully in, the final will not come up to rated plate current this simply

Continued on Page 26.

FOR MORE THAN HALF A CENTURY

This symbol has guided the choice of millions!

DISCERNING PEOPLE EVERYWHERE

Look for this SYMBOL when buying QUALITY

That's why Philips Radioplayers and Philips Lamps sell so readily. Philips is known as a name to trust. There are rich rewards for retailers who tie up with Philips.

PHILIPS ELECTRICAL INDUSTRIES of N.Z. LTD.

AUCKLAND - WELLINGTON - CHRISTCHURCH - DUNEDIN

means that the circuit is adjusted so that it will not present the correct load impedance to the final. This will be the case if the link is not tapped across enough turns on L_1, in which case the loading can be increased by spreading the tapping points by a turn or so each way from the centre-tap. A similar effect will be obtained if the feeders are not tapped near enough to the ends of L_1, or if they are tapped too near the ends. If any loading trouble is experienced, however, it is easily fixed up, because we know that the whole system is in resonance, and that shifting the taps on L_1 will enable the correct loading to be obtained. The golden rule in doing this is to *alter only one thing at a time* and note the effect. For instance, if the feeders are at the ends of L_1, and insufficient coupling is obtained, even with the link fully in, a trial of altering the input link's tappings, one way or the other, will indicate whether an improvement is being made, and whether or not to carry on in the same direction. In practice, however, there is quite a deal of latitude in the adjustment of the tappings, since the swinging link gives a very great deal of variation. The easiest way is to make the coupling between the line and the tuned circuit too tight, rather than too loose, and then couple the swinging link in just enough to give the right plate current.

In the case where the line's reactance is capacitative, and needs inductance shunted across the line to neutralize it, L_2 is inserted, and progressively short-circuited until a value is found which again enables C_1 to tune frequency with its original setting.

We have described in detail the procedure for tuning up with a tuned feeder line. With an untuned line, the procedure is exactly the same. The only difference is that if the line is really untuned, it will be found when C_1 is tuned up, and the line then attached, that the attachment will not have altered the setting of C_1 at all. The tappings can then be adjusted for proper transmitter loading, the intermediate process of tuning out the line's reactance not being required.

MATCHING TO A COAXIAL LINE

The arrangement for feeding a coaxial line is shown in Fig. 5. Here again we have a tuned circuit, but this time both C_1 and C_2 are involved. L_1 can again be similar in inductance to the tank coil in the final amplifier; C_1 does not have to be balanced this time, as the whole circuit is single-ended. Thus, to get the same tuning range we will need C_1 and C_2 in series to have the same capacity as C_1 in Fig. 6. Since C_1 is a split-stator condenser, we will need to use only one half of it in Fig 5, so that the other side of it can be left unconnected without affecting the circuit capacities at all. The way in which Fig. 5 works can be visualized as follows. The tuned circuit L_1, C_1, C_2 is tuned to the output frequency. The coaxial line will normally be used as an untuned line. That is to say, it will have no standing waves on

The iron that's Admired! Desired! by all the fair sex

It's love at first sight when you show lady customers the Morphy-Richards Automatic Safety Electric Iron. Graceful good looks plus a host of special features for easy, effortless ironing invest the Morphy-Richards with appeal that is SALES appeal.

You're sure of a sale when you show customers the famous Morphy-Richards Automatic Safety Electric Iron.

New Zealand Distributors:

Russell Import Co. Ltd.

55–57 Dixon Street - - Wellington

MORPHY-RICHARDS

AUTOMATIC Safety

ELECTRIC IRON

it, and its input impedance will be a pure resistance, equal to its characteristic impedance. In the case of a coaxial line, the latter will be quite low—usually less than 100 ohms—so that the coupling unit will have to act as a step-down transformer. The circuit of Fig. 5 does this because C_1 and C_2 act as a capacity voltage divider. Their point of junction is one of low voltage and high R.F. current, and is therefore a low-impedance point, suitable for attaching a coaxial line to.

The adjustment of this circuit is quite simple, and is done as follows: The final amplifier tank circuit is tuned to resonance. Then C_2 is set at maximum capacity, and with loose coupling between the final tank and the swinging link, C_1 is adjusted to resonance, as shown by an increase in plate current of the final amplifier. Then, the coupling between the aerial unit and the final tank is increased by means of the swinging link, until normal plate current is drawn by the final amplifier. If the setting of C_2 is on the small side, the loading may be too heavy, in which case the tuning of the coupling circuit will be very flat, and it may not be possible to bring the final up to rated plate current. If C_2 is set too large, the loading will be too light. Now the tuning of C_1 will be very sharp, and it will be found that a slight de-tuning of C_1 will have a large effect on the position of the main tank condenser for minimum plate current. In other words, maximum power output and minimum plate current will occur at quite different spots on the final tank's tuning condenser. At a correct setting of C_2, the adjustment of C_1 will still be reasonably sharp, but slight de-tuning of C_1 will have only a minor effect on the required setting of the final tank condenser, and greatest power output will occur at the same setting as minimum plate current. The place at which the tap on L_1 is made, for connecting the input link, is not very critical, since the swinging link allows plenty of variation in coupling between the final tank and the aerial tuning circuit.

OTHER METHODS OF FEED

Although the two general cases we have treated above cover most requirements, one or two other cases may be in common use. For instance, the half-wave end-fed aerial is often used, in spite of its relative inefficiency. Similarly, some may wish to use the single-wire feeder arrangement. Both of these can be accommodated by the circuit of Fig. 5. The latter forms a kind of untuned line, in which the impedance is relatively low, so that the same arrangement of condensers holds, C_2 and C_1 acting as a capacity voltage divider. The adjustment procedure is exactly the same as in the case of the coaxial line. In the case of the end-fed half-wave aerial, it may be necessary to reverse the positions of C_1 and C_2, since the input impedance of this aerial is on the high side. However, the tuning-up procedure is exactly the same as before, but the loading is heavier the larger the condenser in the position of C_1 on the diagram. Other variations are possible, too, but unfortunately, there is not space available to detail them all. We would be pleased, however, to hear from builders who may have any special aerial system that requires feeding, and whose requirements cannot be met by the arrangements already described. It should be noted, however, that we have covered all cases of aerials fed by tuned or untuned balanced lines, so that there should not be much scope for further inquiry!

ROLA "ANISOTROPIC" SPEAKERS ARE GUARANTEED FOR 12 MONTHS FROM DATE OF MANUFACTURE.

AVAILABLE FOR IMMEDIATE DELIVERY EX STOCK

Simon

Acetate Recording Blanks

6-inch to 16-inch double-sided discs of the highest quality.

ATTRACTIVE PRICES TO RECORDING ENGINEERS STUDIOS, ETC.

•

Write, phone, or wire to New Zealand Agents for Simon Sound Service (London):

GREEN and COOPER LTD.

43 Lower Taranaki Street, Wellington

Phone: 54-418 Telegrams: "Fidelatone"

Complete Household REMOVALS

RAIL-AIR For INTER-ISLAND TRANSFERS

Packing and transporting furniture and household effects are tasks for experts —jobs at which the Railways excel. Their specialist rail and road organization and their Cook Strait rail-air link assures dependable service and makes household removals, from and to anywhere in New Zealand, a speedy, money-saving operation. If you've a house-to-house move in prospect, get a quotation from your nearest Stationmaster. You'll find it will pay.

Reliable - Quick - Economical

QUESTIONS and ANSWERS

THE "NEW HIGH-QUALITY AUDIO AMPLIFIER"

C.R.H., Oamaru, writes to ask whether 807's could successfully be used in the above audio amplifier, and if so, what modifications would be required to the feedback circuit.

This amplifier, which was described in the June 1949 issue of *Radio and Electronics,* used push-pull triode-connected EL37's in the output stage. This was preceded by push-pull cathode followers (a single 6SN7 is used here) and again by a stage of push-pull amplification employing a further 6SN7. The remaining tube is a third 6SN7, the first section of which is used as a voltage amplifier, and the second as a phase inverter. Feedback was applied from the secondary of the output transformer to the cathode of the first valve—the voltage amplifier. The performance was particularly good, a total harmonic distortion of 0.15 per cent. being obtained at full output at 1000 c/sec., the figures at other frequencies never rising above 0.5 per cent. anywhere inside the audio range.

It seems a pity to alter a circuit which performs as well as this one, but it is clear what is behind our correspondent's query, namely the economics of the situation. With so many 807's about at almost give-away prices, we can understand anyone's wishing to make use of them! Since others will undoubtedly be interested in the same problem, we will examine it in some detail.

ERSIN

MULTICORE SOLDER

"The finest cored solder in the world."

"THE RED CARTON"

18 S.W.G., 60 per cent. tin, 40 per cent. lead.

High quality radio solder.

List price 7/8 per carton.

Free Samples gladly supplied on request.

N.Z. Distributors:

GILES & ELLIOTT LTD.

9–11 BLAIR ST., WELLINGTON

Telephone: 54-695 Telegrams: "RADOGEN"

The most obvious difference between the EL37 and the 807 for this kind of application is that the former has a very much higher mutual conductance. What difference, if any, will this make? Mostly that the 807's will require higher A.C. grid signal voltage for full output. The question becomes, then, whether the voltage amplifier stages can supply the extra that may be needed without undue distortion. The EL37, triode-connected, and under similar conditions to those which obtain in the amplifier, needs an input voltage of approximately 23v. peak for full power output. The 807 needs 30v. peak, or 21.0 volts R.M.S., which is an increase of almost 50 per cent. In some amplifier designs, this would be enough to put the change out of court, because the voltage amplifying stages are often designed to give full amplifier output right at their maximum output capability, leaving nothing to spare if different output valves are substituted which need more driving voltage. In this case, however, the increase is not so great that the driving valves cannot cope. In the amplifier as originally designed, it was purposely arranged that the voltage amplifier stages should both have plenty in reserve, in order that at full amplifier output, the distortion arising in the voltage amplifiers should be very minute. Thus, substituting the 807's would mean that the distortion from the voltage stages would be very slightly increased, but this is so slight to start with that the extra would hardly be noticed. We do not consider, therefore, that any significant increase in distortion would arise. In any case, a little more negative feedback could be used to counteract any effect there may be.

Another point which would genuinely affect the undistorted power output is that of the plate-to-plate load for the output valves. This was given as 6,600 ohms for the EL37's. For the 807's, however, this figure would be too low, and it would be advisable to raise it to at least 8000 ohms. This will be necessary in the interests of distortion.

It is impossible to say without trial whether the constants in the feedback network will need altering much, but on general principles, it would not be expected that very great alteration would be necessary. The feedback percentage can be changed very easily simply by altering the values in the voltage divider which is connected across the secondary of the output transformer. For a 15-ohm speaker, the original values were 200 ohms and 50 ohms in series, with the feedback taken from the junction, and the 50-ohm resistor earthed at the other end. This value can remain fixed at 50 ohms, and the degree of feedback altered by changing R_{25}, the upper section of the voltage divider. Since the 807's have a lower GM than the EL37's, it might be expected that their voltage amplification would be less, in which case R_{25} would need to be smaller to give the same percentage of feedback. However, this effect will be offset by the increase in the load impedance, and it may well turn out that for a similar degree of feedback, the value of R_{25} may remain almost unchanged. In any event, all that will be needed will be to give R_{25} such a value that the gain without feedback is four times that with the feedback connected.

Apart from changing the plate-to-plate load resistance, and altering the cathode resistor to suit the 807's, no other circuit changes should be needed.

THE "RADEL" FREQUENCY-MODULATED TEST OSCILLATOR

This is one of our older circuits, but F.J.M., Napier, writes with some queries regarding circuit values. Incidentally, for the benefit of those who may wish to refer to the circuit, this appeared in the February 1948 issue of *Radio and Electronics.* Our correspondent asks:

(1) What is the capacity of C_{12}, which was omitted from the parts list.
(2) What voltage is needed for the H.T. winding of the power transformer.
(3) I have been unable to obtain a 175 kc/sec I.F. bobbin, such as is suggested for making the oscillator coil. Would two 465 kc/sec. windings in series be a suitable substitute?

Taking these questions in order:

(1) C_{12} is a 0.001μf. mica condenser, to act as a bypass for R.F. in case the electrolytic smoothing condenser does not work as a bypass at the oscillator frequency.
(2) The power transformer is a small instrument type, 150v.-a-side.
(3) Without experimenting it is not possible to say whether the coils suggested would be satisfactory, but we are sure that our correspondent could obtain 175 kc/sec. bobbins by writing to some of the firms in Wellington or Auckland who specialize in mail-order business.

USING VARIABLE-SELECTIVITY I.F. TRANSFORMERS

"C.R.H.," of Oamaru, writes as follows:—

"Would it be satisfactory to use variable selectivity I.F. transformers in a set which has an R.F. stage. I note that all the tuners your magazine has featured with variable selectivity have not had a stage of R.F. amplification, and wonder whether there is any particular reason for this."

There is a good reason for not using an R.F. stage where variable selectivity is incorporated in a set, but with reservations. It is conceded that sets are built, quite successfully, which have both features.

We have given the reason behind the non-employment of R.F. stages where variable selectivity is featured in various articles, but there should be no harm in briefly recapitulating here. It is that with variable selectivity, it is more important than usual to see that the set has not the slightest suspicion of regeneration or potential instability. Having no oscillation is not necessarily good enough, because if regeneration exists, but not enough of it to cause oscillation, it can still have the direct effect on the shape of the over-all selectivity characteristic of the set. Leaving out the R.F. stage is the easiest way of making absolutely certain that regeneration is not present in sufficient quantity to vitiate our attempts, via variable selectivity, to increase the band-width of the tuner. If an R.F. stage is used, extra special precautions must be taken against instability. That is, lay-out in the R.F. section must be carefully done, and all R.F. signal leads must be short and remote as possible from other similar leads. Also, the set must be aligned with as much precision as possible, because improper tracking of the signal and oscillator circuits in a superhet can also have an adverse effect on the overall selectivity curve. A way of testing whether all is well or not is to draw two selectivity curves after the set has been aligned. One is taken with the signal generator fed into the mixer grid, and will show the selectivity curve of the I.F. section alone, if the input is at I.F. Then, the signal generator is transferred to the aerial terminal, and a selectivity curve taken with an input frequency of, say, 1000 kc/sec. Any marked differences between the two selectivity curves is due to the extra selectivity provided by the signal circuits, which are left out of consideration by the first curve, but included when the second is taken.

NEW STOCKS NOW AVAILABLE

GARRARD RECORD CHANGERS AND SINGLE PLAYER UNITS

Garrard RC65 Changer with Crystal Pick-up	£13 15 0
RC70 Changer with Hi-Fidelity Pick-up	£9 13 0
RC70 Changer with Miniature Mag. Pick-up	£10 7 3
AC6 Gram units with Magnetic Pick-up	£6 4 6
Type S Gram units with Magnetic Pick-up	£4 13 0

Also available are replacement pick-up heads for all Garrard Units

ROLA E.M. Speakers in all sizes.
TURNER CRYSTAL Microphones S22X and S34.
EX WAR ASSETS VALVES. New in sealed cartons—
807's only 6/-, 6U7's 1/9 each

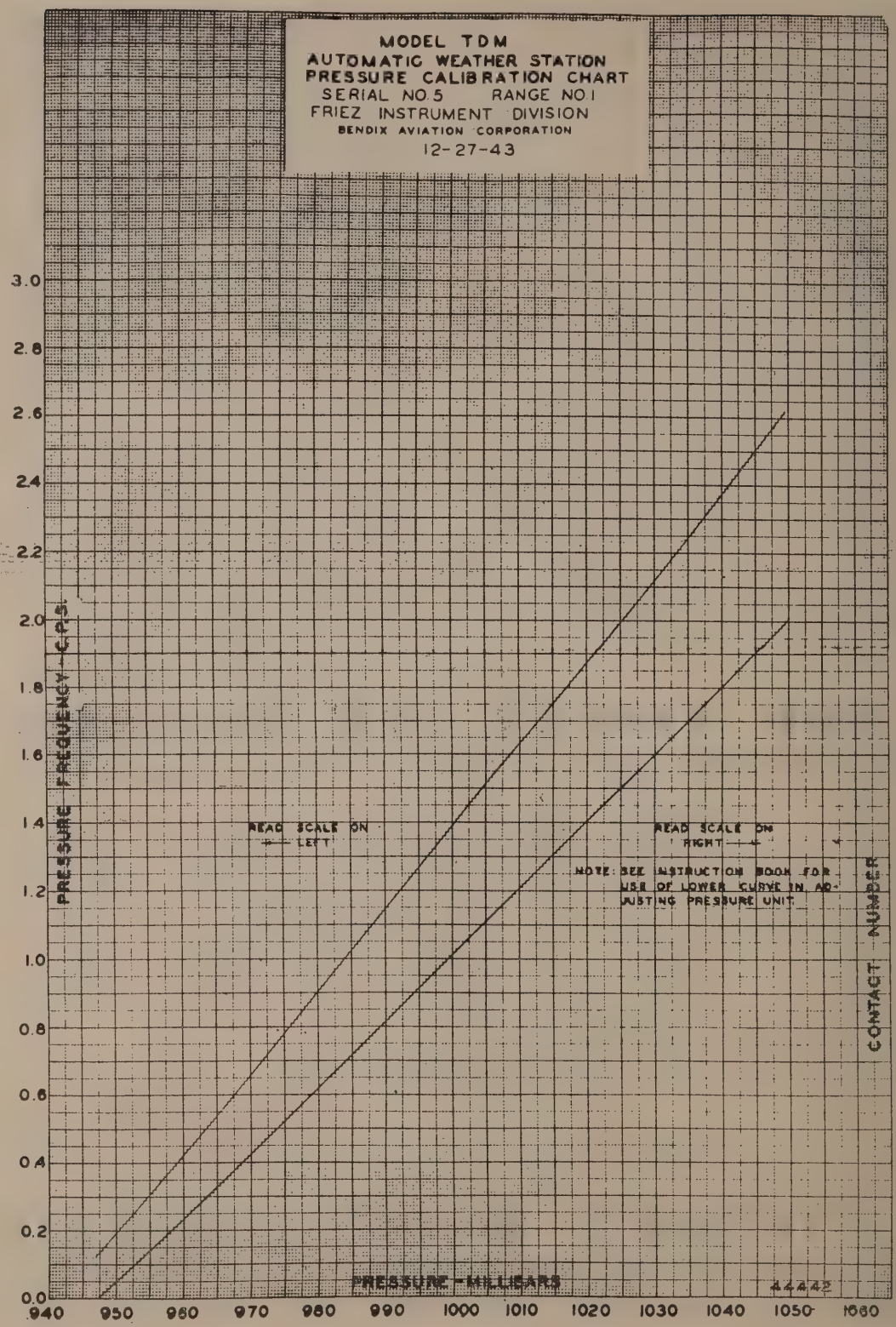
Permit us to quote you on all your receiver and amplifier parts requirements. Our prices are right.

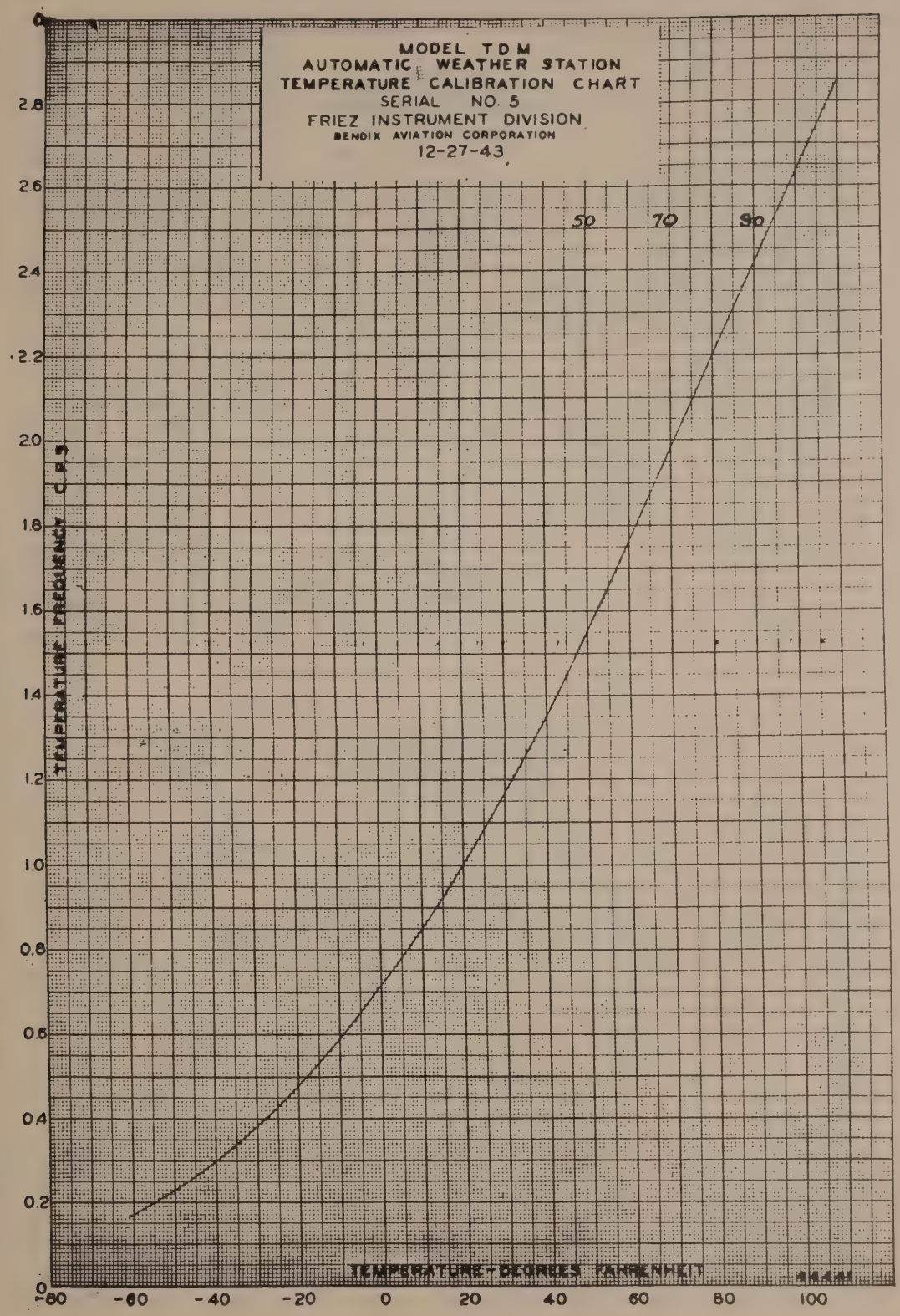
WEBB'S RADIO LIMITED

11 WELLESLEY STREET EAST, AUCKLAND - - TELEPHONE 49-233

Charts for Reading The Automatic Weather Station Transmissions

PLEASE SEE PAGE 23




MODEL TDM
AUTOMATIC WEATHER STATION
TEMPERATURE CALIBRATION CHART
SERIAL NO. 5
FRIEZ INSTRUMENT DIVISION
BENDIX AVIATION CORPORATION
12-27-43
50
70
90
TEMPERATURE FREQUENCY C.P.S.
TEMPERATURE - DEGREES FAHRENHEIT
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
-80
-60
-40
-20
0
20
40
60
80
100

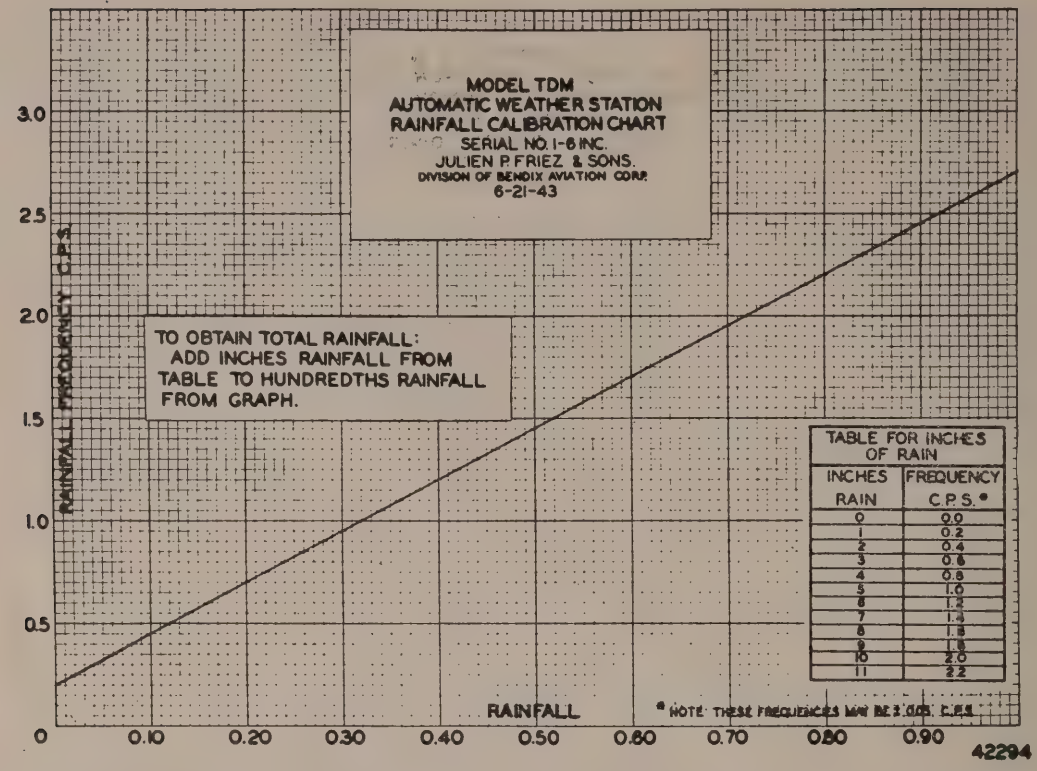
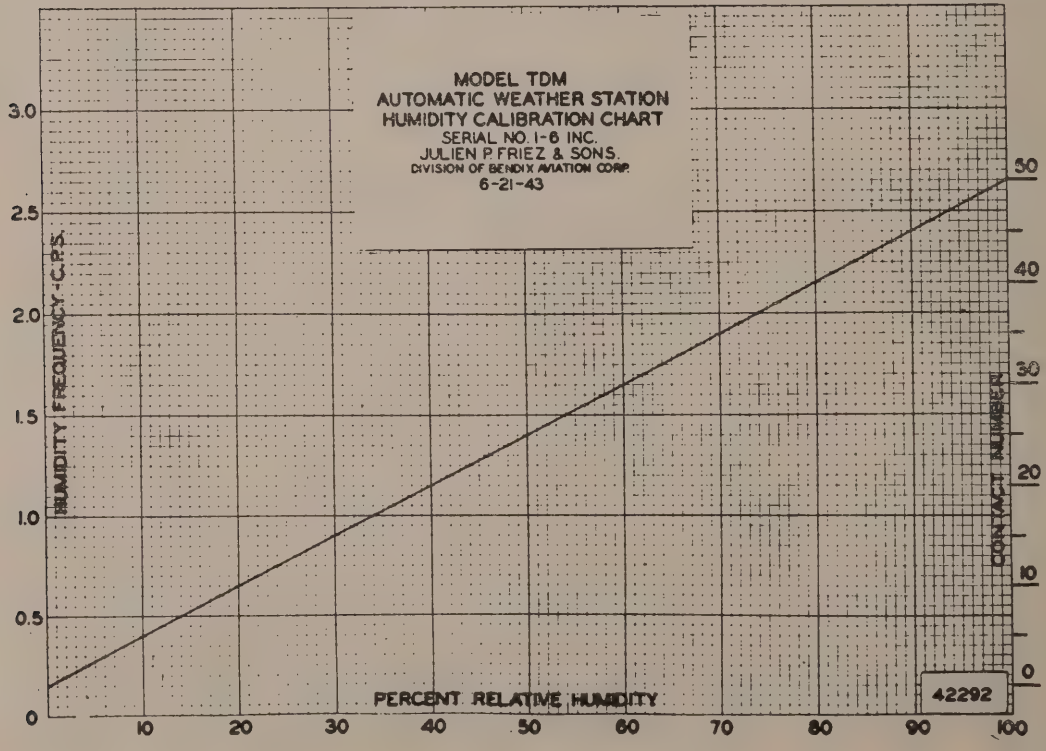
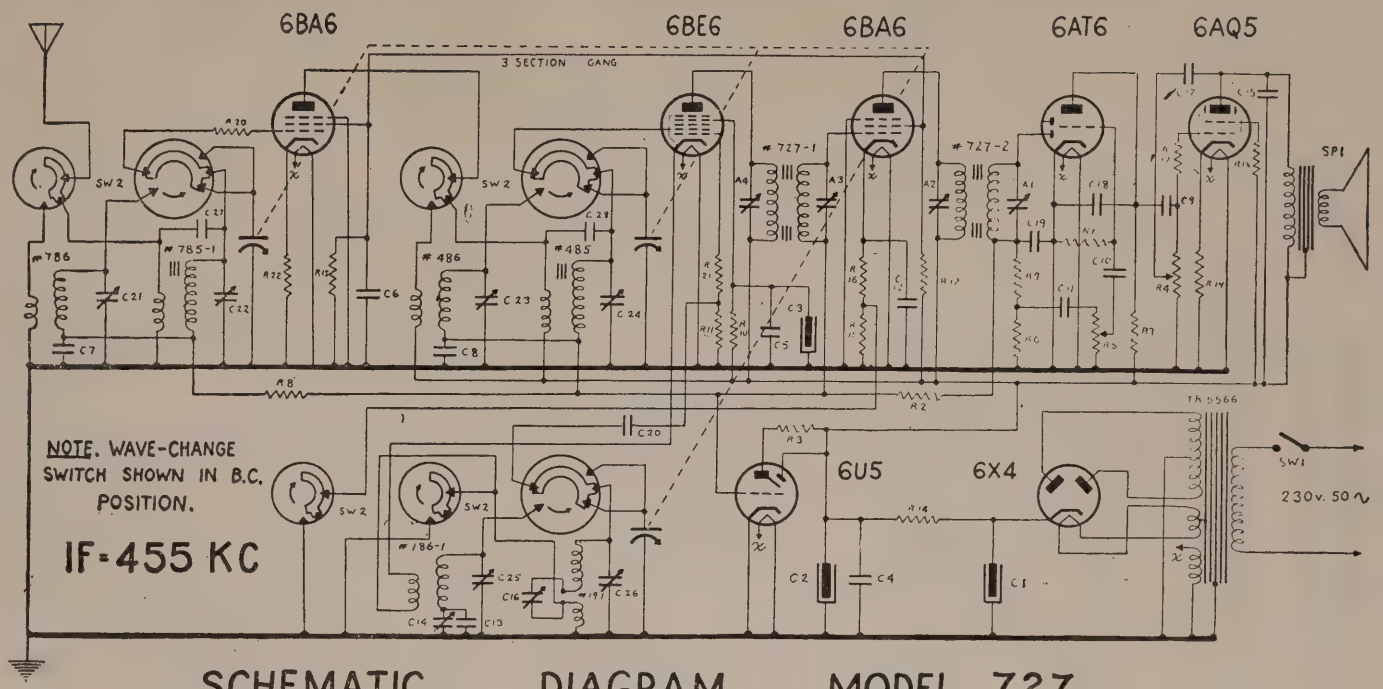


TABLE FOR INCHES OF RAIN

INCHES RAIN	FREQUENCY C.P.S.*
0	0.0
1	0.2
2	0.4
3	0.6
4	0.8
5	1.0
6	1.2
7	1.4
8	1.8
9	1.8
10	2.0
11	2.2

* NOTE: THESE FREQUENCIES MAY BE 3 CPS. C.P.S.





SCHEMATIC DIAGRAM MODEL 727

VOLTAGE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	6BA6	0	0	0	6.3 A.C.	215 v.	85 v.	.8 v.	
Conv.	6BE6	—4 v.	0	0	6.3 A.C.	215 v.	90 v.	0	
I.F.	6BA6	0	0	0	6.3 A.C.	215 v.	85 v.	5.6 v.	
Det-AF.	6AT6	.4 v.	0	0	6.3 A.C.	0	0	72 v.	
Output	6AQ5	0	12 v.	0	6.3 A.C.	208 v.	215 v.	0	
Rect.	6X4	3 35A.C.	0	325 v.	325 v.	0	335 A.C.	325 v.	
Eye	6U5	0	20 v.	0	215 v.	0	6.3 A.C.		

1. D.C. voltage measurements are at 2,000 ohm. per volt—A.C. voltage measured at 1,000 ohm per volt.
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative. Bandswitch in B.C. position.

RESISTANCE READINGS

Use	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8
R.F.	6BA6	1.8 meg.	0	0	0	16K	12K	75 ohm	
Conv.	6BE6	20K	0	0	0	16K	15K	1.5 meg.	
I.F.	6BA6	1.5 meg.	0	0	0	16K	12K	3.2K	
Det-AF.	6AT6	10 meg.	0	0	0	500K	Inf.	400K	
Output	6AQ5	Inf.	270 ohm	0	0	16K	16K	500K	
Rect.	6X4	315 ohm	Inf.	17K	17K	Inf.	320 ohm	17K	
Eye	6U5	0	1.17meg	1.5 meg.	16K	0	0		

4. Nominal Tolerance on component value make possible a variation of ± 10% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.
6. Resistance readings in B+ circuits may vary widely according to the condition of filter capacitors.

TECHNICAL INFORMATION

COVERING

DUAL WAVE RECEIVER TYPE 727

COLLIER & BEALE Ltd., WELLINGTON

TYPE SET—A.C. Superhetrodyne.

TUBES (Seven)—6BA6 R.F. Amp., 6BE6 Converter, 6BA6 I.F. Amp., 6AT6 Det.-A.F., 6AQ5 Power Output, 6U5 Tuning Indicator, 6X4 Rectifier.

POWER SUPPLY—230 v. A.C. Rating, 60 watts.

TUNING RANGE—Broadcast, 535-1625 K.C., Shortwave, 5.9 m.c.-19 m.c.

ALIGNMENT INSTRUCTIONS

To set pointer, fully mesh variable condenser and set pointer at last reference mark at left end of dial. Set volume control as maximum and keep output from signal generator no higher than necessary to obtain output reading.

Dummy Antenna	Signal Generator Coupling	Sig. Gen. Frequency	Band Switch Position	Radio Dial Setting	Output Meter	Adjust	Remarks
.1 mfd.	High side to pin No. 7 (grid) of 6BE6	455 Kc.	B.C.	High freq. end	Across voice coil	A1, A2, A3, A4.	Adjust for maximum output
R.M.A. Standard	High side to ant. Terminal	1400 Kc.	„	1400 Kc.	„	C26	„ „
„	„	1400 Kc.	„	1400 Kc.	„	C24 & 22	„ „
„	„	600 Kc.	„	Rock Variable	„	C16	Recheck C26 at 1400 Kc. If C26 is changed recheck C16
„	„	18 Mc.	S.W.	18 Mc.		C25	Adjust for maximum output
„	„	18 Mc.	„	18 Mc.	„	C23 & 21	

CAPACITORS

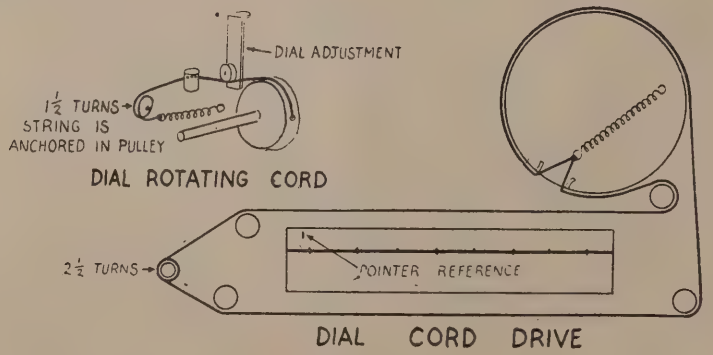
Ref. No.	Cap.	Volts
C1-2	40+40mfd.	450
C3	8mfd.	450
C4-6	.1mfd.	600
C7-8	.05mfd.	600
C9-13	.01mfd.	600
C13	.0035mfd.	mica
C14	1,000mmfd.	padder
C15	.001mfd.	mica
C16	600mmfd.	padder
C17	.0005mfd.	mica
C18-20	.0001mfd.	mica
C21-24	3-30mmfd.	trimmer
C25-26	3-30mmfd.	ceramic trimmer
C27-28	5mmfd.	ceramic

MISCELLANEOUS

Ref. No.	Res., Pri.	Res., Sec.	
785-1	20 ohm	2.4 ohm	
485	69 ohm	2.4 ohm	
191	.24 ohm	2.25 ohm	
786	.4 ohm	.03 ohm	
486	1 ohm	.03 ohm	
186-1	.42 ohm	.03 ohm	
727-1	6.75 ohm	6.75 ohm	
727-2	6.75 ohm	6.75 ohm	
	Volts	**Volts**	**Volts**
TR5566	230	350 aside	2 x 6.3
	Type	**Transformer**	
SP1	8" P.M.	5,000 ohm	
SW1	S.P.S.T. switch attached to R4		
SW2	D.W. bandswitch SW5282		

RESISTORS

Ref. No.	Res.	Watts
R1	10 meg.	½ watt
R2-3	1 meg.	½ watt
R4-5	.5 meg.	pot.
R6	.5 meg.	½ watt
R7-8	.25 meg.	½ watt
R9	50,000 ohm	½ watt
R10	25,000 ohm	1 watt
R11	20,000 ohm	½ watt
R12	15,000 ohm	2 watt
R13	15,000 ohm	1 watt
R14	1,500 ohm	5 watt
R15	1,500 ohm	½ watt
R16-18	500 ohm	½ watt
R19	270 ohm	1 watt
R20	150 ohm	½ watt
R21	100 ohm	½ watt
R22	75 ohm	¼ watt



DIAL CORD DRIVE

FERRANTI *ELECTRIC ALARM CLOCK*

The new FERRANTI Model 947 Alarm Clock retains the features of a 24-hour setting.

Once set, the alarm operates every 24 hours at the required time and does not require re-setting.

•

Ask your electrical dealer to show you the NEW
FERRANTI MODEL 947 ELECTRIC ALARM CLOCK

•

New Zealand Agents:

ARTHUR D. RILEY & Co. Ltd.

124 Hobson Street
AUCKLAND

66–68 The Terrace,
WELLINGTON

LIMITED TELEGRAPH STOCKS

Prices Absurdly Below VALUE

•

EX1490 Telegraph Resistance Boxes, Total possible resistance, 1100 ohms. Increases of 10 ohms to 40, and 100 ohms to 400. Ideal for accurate checking of resistances. 15/- each

EX1501 Galvanometers (Siemens) 1½in. pointer on vertical scale—all under 3 in. dia. Heavy glass dome. 12/6 each

EX1497 Telegraph Morse Keys, 6 Terminals. Value! 15/-

EX1493 Telegraph Morse Transmitters 10/-

EX1492 Telegraph Pole Changers 12/6

Resistors—Porcelain former 6in. long, 1in. diameter.

EX1507 3000-ohm 100-watt 4/- each

EX1506 1700-ohm 100-watt 4/- each

Switches—Rotary disc

EX1495 1 pole, 5-way 3/6 each

EX1496 4 pole 2-way 3/6 each

Switches—mounted on 4in. circular block—

EX1498 2 circuit changeover 7/6 ea

EX1499 2 way 3 terminals 2/– ea

EX1500 Telegraph Sounders 7/6 ea

ORDER NOW THROUGH OUR MAIL ORDER DEPARTMENT

THE LAMPHOUSE

11 MANNERS STREET
WELLINGTON

The Transistor-An Amplifying Crystal

By the ENGINEERING DEPARTMENT the AEROVOX CORP.

Among recent technical developments, the "Transistor" or semi-conductor triode, will probably have the most far-reaching effects upon every field of electronics. Although still in an embryonic stage comparable to that represented by the de-Forest "audion" in the development of the vacuum tube, the implications of this tiny, heaterless, vacuumless capsule are so tremendous as to warrant the interest of every worker in the radio field.

Just as the unidirectional conduction of current in the thermionic diode (Edison effect) was known for over 24 years before the addition of a third controlling element in the form of a grid, the rectifying properties of such semi-conductors as galena, iron pyrites, silicon and germanium have been used in radio applications for many years. During this time very little thought was given to

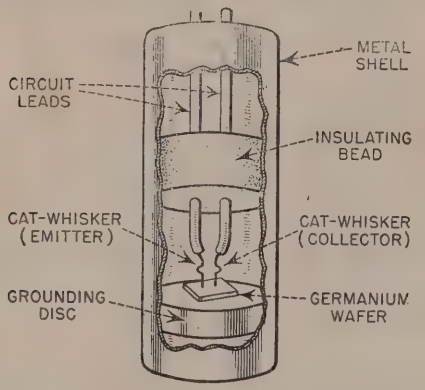
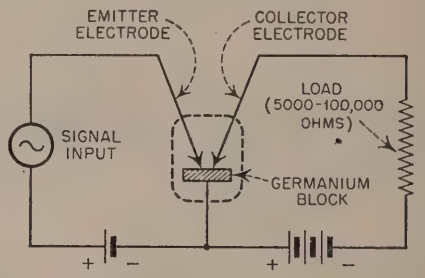


FIG. 1

the possibility of electronically controlling such rectification. However, due to impetus gained through the widespread use of crystals as microwave mixers and detectors during the last war, recent research in the field of semiconductors has resulted in the discovery of the crystal triode, or Transistor.

Physically, the transistor consists of a conventional crystal diode such as was used in great numbers during the last war in radar receivers, modified only by the addition of a second "cat-whisker" contact. This makes contact with the germanium semi-conductor at a point very close to the point of contact of the first cat-whisker, but is otherwise insulated from it. It is the addition of this element to the device which permits control of the current flowing to the first and enables it to perform many of the functions of a vacuum tube triode, although in a different way, as will be shown.

The construction of the transistor, as pioneered by the Bell Telephone Laboratories, is shown in Fig. 1. This mounting closely resembles the "co-axial cartridge" type commonly used in rectifier crystals, except that two centre conductors are used. A small rectangular "wafer" of the semi-conductor (germanium crystal) is soldered to a brass disc, which in turn is fitted into one end of a small metal tube approximately 3/16 inch in diameter and $\frac{3}{4}$ inch long. Thus the device is comparable in size to a half-watt resistor. The two cat-whiskers are of tungsten wire approximately .002 inch in diameter welded to the ends of rigid wire terminals which in turn are spaced by an insulating bead. This supports them within the metal tube so that both cat-whiskers are brought into contact with the highly polished surface of the



BASIC TRANSISTOR CIRCUIT
FIG. 2

germanium. The separation between the points of contact is maintained at between .002 and .005 of an inch. The structure is ruggedized against mechanical shock and vibration by impregnating the capsule with a low-loss wax compound which also renders it moisture proof. It is probable, that, as the development of this mechanically simple device progresses, new applications will dictate radical departures from this preliminary design.

Experimental applications to which the transistor has been adapted include: radio-frequency amplifier stages, audio and R.F. oscillators, intermediate frequency amplifiers, audio amplifier stages and other types of circuitry now commonly employing vacuum tubes. As yet, the upper frequency limit of the transistor is about 10 megacycles per second, but there appears to be no fundamental reason why this range of usefulness cannot be extended into at least the VHF region to include television and F.M. applications. However, transit-time effects, inherent in semi-conductor devices as in negative-grid vacuum tubes, will probably limit operation beyond the VHF range. Although diode crystal rectifiers are efficient as detectors and converters of microwave energy at frequencies exceeding 25,000 megacycles/second, the type of high-inverse-voltage germanium semi-conductor used in the present transistor is not an efficient rectifier at frequencies much above 60 megacycles/sec.

Another limitation to the use of the transistor in some circuit applications is the excessive noise voltages generated within it at present. This noise is about 70 db. above the theoretical thermal or *Johnson Noise,* which is defined as the noise that would be generated in an equivalent resistance due to the random motion of thermally agitated electrons within it. This objectionable noise characteristic is most pronounced at the audio frequencies and appears to decrease somewhat with frequency. Future laboratory work will undoubtedly result

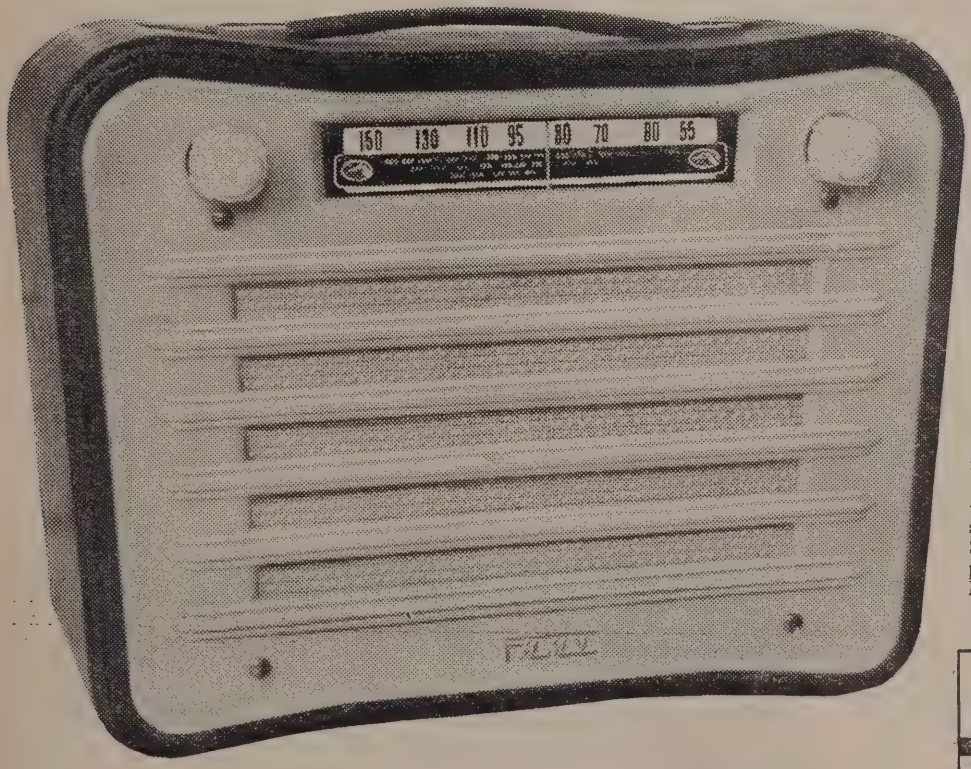
in methods of reducing such noise to more usable levels. If noise figures comparable to those encountered in the modern vacuum tube are achieved, the transistor will replace tubes in many low-power applications, since it consumes no heater or filament power, requires no warm-up time, is virtually heatless in operation and is more compact and rugged than even the subminiature vacuum tubes. Because of these advantages, transistors will find use in circuits where economy of power consumption and extreme compactness are desirable. Such circuits may include ultra-portable broadcast receivers using printed wiring and components, electronic computing devices which may require as many as 18,800 vacuum tubes (as in the ENIAC), electronic musical instruments which also use hundreds of vacuum tubes operating at low audio levels and other more conventional applications. The mere fact that the transistor does not require a vacuum is an important advantage, since the production and maintenance of a satisfactory high vacuum is an item of major expense in the manufacture of electron tubes. In addition, the operating efficiency of the transistor exceeds that of vacuum tubes in many applications, especially when it is considered that no heater power input is required. Operating efficiencies as high as 25 per cent. have been observed at output levels of from 10 to 20 milliwatts.

The basic electrical circuit of the transistor is shown in Fig. 2. The input electrode, which is called the "emitter," is maintained at a small positive potential with respect

Designed for the Out of Doors Enthusiast

-it also makes a perfect "Plug-in set" for the home.

H.M.V.
CAMBRIDGE
PORTABLE



The new Cambridge A-C Battery Portable will give you equal satisfaction in the home or out of doors. Listen at leisure to your favourite programmes — on sun drenched beaches; picnic grounds or in the luxury of home comforts! Your Cambridge is a friend you can trust — a friend that you can always have at your side! See this H.M.V. general purpose radio at your H.M.V. dealer.

"HIS MASTER'S VOICE"

Head Office: His Master's Voice [N.Z.] Ltd., Box 108 Wellington.

to the germanium block. The impedance to current flow in this direction is low (100–400 ohms) due to the rectifying action of the germanium-tungsten contact. Therefore, this small positive "bias" voltage (0.1 to 0.5 volt) causes an appreciable "forward" current to flow in the emitter circuit. Also, because of this low impedance to forward currents, a small increment in emitter voltage caused by an impressed signal will result in a large increase in electron current flowing from the semi-conductor to the cat-whisker. The static voltage-current characteristic of the emitter circuit, when considered alone, is similar to that of the typical germanium point-contact rectifier, which is shown in Fig. 3. On the other hand the "collector," or output contact of the transistor, is biased negatively with respect to the germanium. At this polarity, the impedance to current flow is relatively high (exceeding 10,000 ohms), so that over 30 volts may be applied to the collector before appreciable "back" current flows in the semi-conductor. The dotted portion of Fig. 3 represents

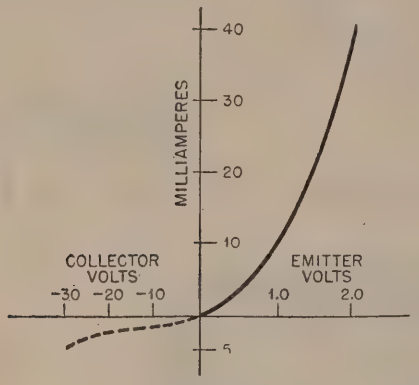


FIG. 3

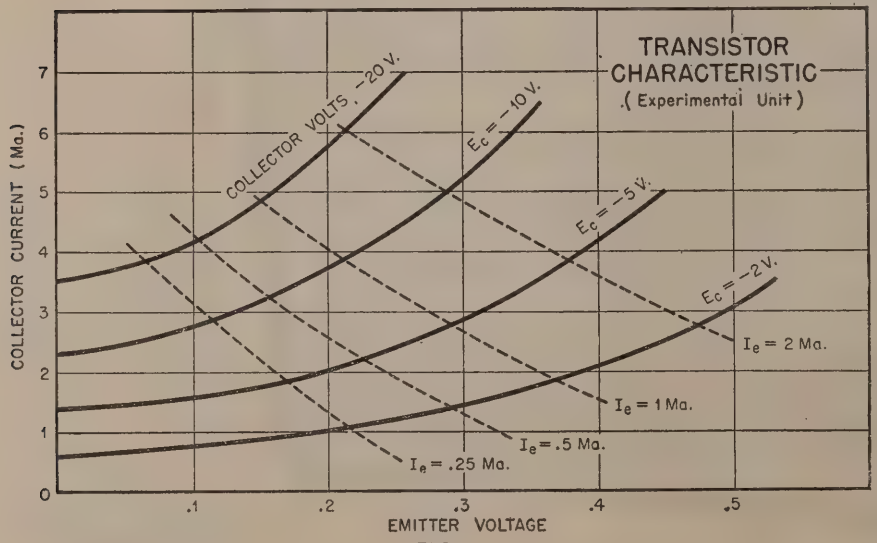


FIG. 4

the static (no load) characteristic of the collector circuit in the absence of the emitter. The close proximity of the two cat-whiskers with their respective operating voltages modifies these characteristics considerably, however. It is the ability of the transistor to transfer an emitter voltage change to the collector circuit in the form of a resistance change, which gives the device its name, which means TRANSFER RESISTOR. This property results in effective power gains of 100 times or 20 db. being possible.

To understand the mechanism whereby emitter circuit power variations induce relatively larger power variations in the collector circuit and hence, enables the transistor to amplify, it is necessary to examine the fundamental properties of semi-conductors. Although the theory of the transistor is still not completely understood and may be subject to frequent revision, a working concept of its operation can be gained from a simplified analysis and by drawing analogies to vacuum tube circuits.

It will be recalled that the resistance properties of substances depend on the number of free electrons available in the molecular structure for the conduction of current. In some materials the electrons in the outer "shells" or orbits of the atoms are so loosely bound to the nuclei that they are easily removed and may move about between atoms under the influence of thermal agitation. If an external stimulus is applied, such as the connection of a battery across such a material, the random motions of these free electrons within it are co-ordinated into a unidirectional current flow. The metals, which may have as many as one or two free electrons per atom, are examples of such materials which are good conductors of electricity. Other substances, on the other hand, may have virtually no free electrons available for current conduction and so are classed as insulators. The semi-conductors are intermediate between metals and insulators in the scale of conductivity, having perhaps only one free electron for every million atoms. The extent and type of current conduction possible within them is dependant upon the very minute quantities of impurities present. Thus, although perfectly pure germanium (if obtainable) would be a very poor conductor at normal temperatures, the addition of quantities as small as 0.001 per cent. of tin or some other impurity provides enough free carriers for conduction to be possible. The word "carriers" is used here since current in a semi-conductor can be carried in two distinctly different ways; by the presence of free electrons within it, or by the absence of some of the "bound" ones. The latter type of conduction the solid-state physicist has termed "conduction by holes." These "holes" are vacancies in the otherwise filled lines of *valence* electrons which make up the interatomic bonds of the crystal, and they constitute *virtual* positive charges. They may move along in a random manner by being filled in by an adjacent electron, which in turn leaves a "hole" behind it. Thus, the process continues with the "hole" moving at rather high speed through the crystal as the atoms attempt to maintain equilibrium between themselves. If

a voltage is applied across such a semi-conductor, the holes, being positive in nature, are attracted to the negative electrode instead of to the positive electrode as is the case of free electrons. Whether a semi-conductor conducts by the extra negative electron process (n-type), or the "positive hole" process (p-type), depends on the kind of impurity added. Thus, silicon "doped" with aluminium or boron impurity is a p-type semi-conductor, while silicon containing minute quantities of phosphorus is an n-type. If the added impurity atom has one less valence electron than the semi-conductor atom, a p-type ("hole") semi-conductor results. If it has one more valence electron, an n-type crystal results. The type of conduction in germanium can also be changed by heat-treatment.

In the transistor, both n-type and p-type current conduction are present. The emitter is biased positively so as

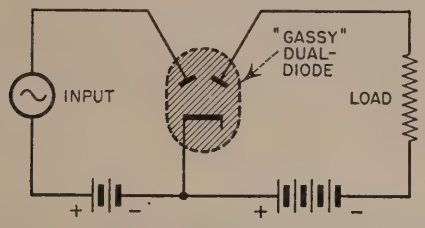


FIG.5

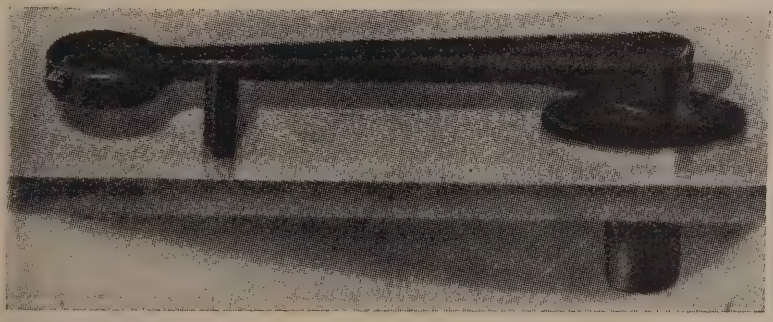
to attract free electrons which surmount the rectifying barrier layer at the interface of the semi-conductor-to-metal contact and flow in the input circuit. The collector, biased highly negative, attracts a small number of "holes" in the absence of emitter current. The useful property of the transistor arises from the fact that a flow of electron current to the emitter cat-whisker causes the formation of many more electron vacancies or "holes" at the surface of the semi-conductor which are gathered by the nearby collector cat-whisker. The result is an increase of output current. A change in the emitter circuit current "modulates" the number of "holes" available to the collector and thus causes a similar change in collector current. Although the current changes in the input and output circuits are of similar magnitude, amplification results since the collector circuit impedance is approximately 100 times that of the emitter circuit. Fig. 4 shows the way in which the collector current and emitter current vary with emitter voltage at given value of collector voltage.

A vacuum tube circuit which has characteristics closely analogous to the action of a transistor is shown in Fig. 5. In this circuit the transistor is replaced by a dual-diode vacuum tube which contains a small quantity of residual gas. The two small anodes are spaced close together and are biased by voltages of similar polarity to those applied to the two contacts of the transistor. The anode which is at a small positive potential with respect to the cathode has characteristics which are comparable to the emitter electrode; it attracts electrons from the cathode and thus its circuit presents low impedance to "forward" current flow. The diode plate which is biased negatively is analogous to the collector cat-whisker of the transistor in that the circuit impedance is very high and little current flows in its normally. However, the flow of current in the "emitter" may be made to increase the current flowing in the collector circuit. Electrons being accelerated toward the emitter anode may collide with residual gas molecules, remove electrons from them, and thereby form positive ions which are drawn to the negative collector anode. These ions are roughly analogous to the "holes" in the transistor case since they behave like positive particles and move more slowly than electrons. The number of ions formed depends upon the number of eletcrons flowing to the emitter anode. Therefore, the input circuit controls the flow of current in the output circuit, just as in the transistor and conventional vacuum tube amplifiers.

The advent of the transistor opens fertile fields for future development. Much remains to be done in the adaptation of conventional circuitry for use with this simple device. Problems frequently arise since the electrode voltage polarities and circuit impedances differ so greatly from those encountered in vacuum tubes. The cascading of amplifier stages is complicated by the fact that the input and output impedances do not lend themselves well to the usual schemes of interstage coupling. The possibility of push-pull and paralleled units for increased power output is still to be fully exploited.

Because of its simple structure and the small amount of test equipment required, the transistor provides a valuable subject for individual experimentation. Transistors have been fabricated for study purposes from germanium removed from standard 1N34 diode crystal rectifiers suitably mounted with two adjustable fine wire cat-whiskers.

BRIERLEY PICK-UPS



Microarmature JB/P/A/I
Ribbon Type JB/P/R

These two pick-ups are individually made instruments for those who take pride and obtain pleasure in reproduction that is as nearly perfect as present technical development permits. Here are characteristics of ribbon:

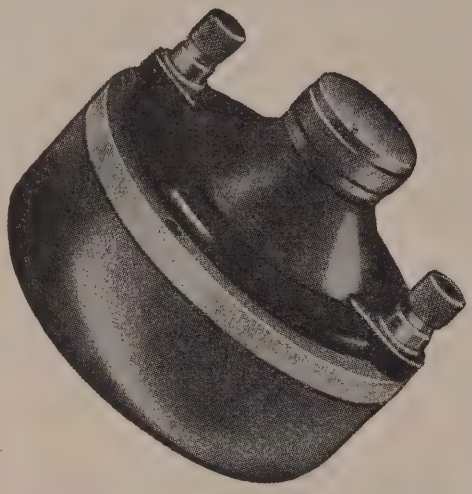
* The point is 85 times harder than sapphire.
* Total mass moving parts 17 milligrams.
* Effective mass moving parts 4 milligrams.
* Downward pressure ½ oz.
* Low-frequency resonance 5 c/s. (approximately).

FREE! Write today for illustrated pamphlet to

RADIO REPAIRS LTD.
7a Great North Road Auckland

VITAVOX

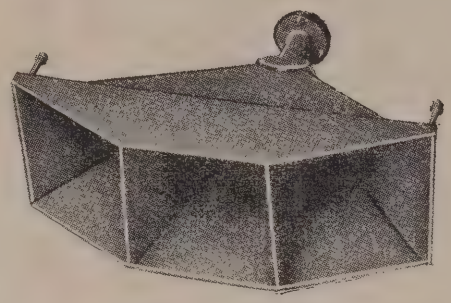
Music Re-Creation



IT is no coincidence that high-quality sound-reproducing equipment is two-way in design, nor is it a coincidence that a multicellular horn, separate from the low-frequency radiator, is recognized as the best and most flexible way of handling the reproduction of the higher frequencies.

THEREFORE, those who seek after the best will note with satisfaction that at last there is available, for home record-reproducing purposes or otherwise, a complete range of equipment which can be fitted satisfactorily into cabinets or enclosures of reasonable dimensions.

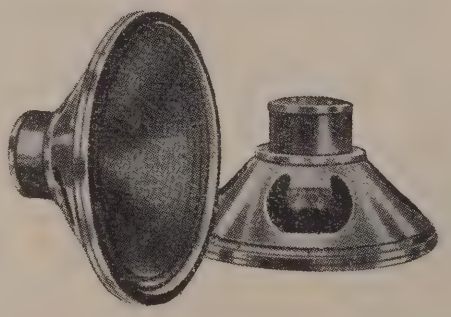
The following units are manufactured in the finest tradition by Messrs. Vitavox, Ltd., of London.



The New G.P.1 Unit—new in design, new in construction, new in performance (frequency response 250–14,000 cycles/sec., impedance 15 ohms)—will handle smoothly and without discrimination all frequencies from cross-over to high-frequency attenuator. Fitted with light alloy diaphragm—tangenital compliance—and internal phase corrector, this unit performs brilliantly when coupled to—

Type 550 Multicellular Horn. Made up of three truly exponential cells and constructed of sandwich metal, it is without resonance. Cut-off frequency is 550 cycles/sec., and the dimensions are such that coverage is adequate in all directions. Dimensions 13 in. deep, 15 in. wide, 5 in. thick.

700-cycle cross-over networks, with a 12 db. per octave rate of attenuation, will separate the frequencies with little loss and prevent "spill-over" and intermodulation effects. These provide the necessary coupling for the



Type K12/10 and K12/20 Low-frequency Speakers. Faithfully constructed, with Ticonal magnets to ensure high flux density in the gap, these speakers, mounted in either a vented baffle or a totally-enclosed cabinet, will perform in their spectrum in a manner faultlessly matched to that of the high-frequency units. Cone resonance 75 cycles/sec., impedance 15 ohms, 12 in. diameter.

NEW

Now available, a new low-frequency speaker for the ultimate in bass end reproduction; 15 in. in diamater and capable of handling 40 watts, it has a natural cone resonance of 42 cycles, but a 30-cycle cone can be supplied for use in horn-loaded baffles only. Designed to meet the exacting requirements of the theatre industry, but available shortly for the home record player.

For further information, see your dealer or write to—

W. G. LEATHAM LIMITED.

104 FEATHERSTON STREET, WELLINGTON :: :: :: P.O. BOX 1284

THE NEW ZEALAND ELECTRONICS INSTITUTE (INC.) NEWSLETTER

Due to the Christmas holidays and the subsequent rush of business thereafter, districts have not been very active, but commencing from February activities have been more pronounced.

A slight delay has occurred in the issuance of certificates to members, but these are now in course of preparation and it is hoped that all those entitled to receive certificates will do so in the near future.

Institute Insignia: Additional designs for an insignia for the Institute may still be submitted, and the Council would no doubt welcome such designs as may be suitable and appropriate for the Institute to utilize.

Members are advised that through the courtesy of Philips Electrical Industries of New Zealand Ltd., bulletins are being made available to all our branches for placing in their libraries. The Council is most appreciative of the action of Philips Electrical Industries in assisting the education of members in this matter.

Otago Branch: A monthly general meeting of the Otago Branch was held in December last, when a lecture by Mr. W. Collett, B.Sc., was given on "Industrial Applications of Electronics." This lecture dealt with:—

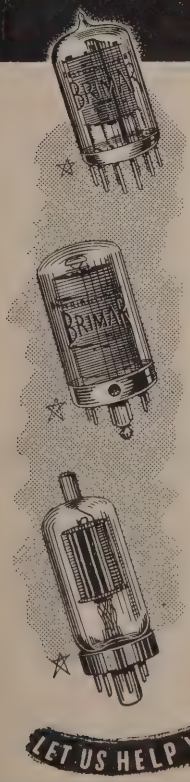
(*a*) Control Devices;
(*b*) Safety Devices;
(*c*) Measuring and Detection Devices;
(*d*) Production Equipment.

The lecture was followed with keen interest by those present, and the lucid explanations, together with the circuits and details, left no doubtful points in the operation of these electronic devices.

Wellington Branch: On the 15th January last Wellington Branch members had a day's outing at Titahi Bay. A picnic on the beach was followed by an inspection of the new transmitters at this station, and Wellington members who attended were most appreciative of the courtesy of Mr. Gilby in explaining details in connection with the transmitters and generally in making the visit a success.

A committee meeting of Wellington Branch was held on the 7th February, and members will be informed shortly of activities for the forthcoming session.

New VALVE TYPES HAVE BEEN ADDED AND WE Can SUPPLY



The Brimar valve factory at Standard Telephones and Cables Ltd., London, have added new types to their range. Here is a list of some of the types available now.

	R.F. Tubes	Mixer Tubes	I.F. Tubes	2nd Detector	Output Tubes	Rectifier Tubes
1.4-volt Battery Types	1T4	1R5	1T4	1U5	3V4	—
6.3-volt Loctal Types	7H7	7S7	7H7	7K7	7C5	7Z4
6.3-volt Octal Types	6K7GT	6K8GT	6K7GT	6B8GT	6V6GT	5Y3GT
6.3-volt All Glass Types	6BA6	6BE6	6BA6	6AT6	6AM5	6X4

Additional types in the above ranges together with other British Brimar made American replacement types, including 12-volt loctals are also available.

BRIMAR

LET US HELP YOU WITH YOUR PROBLEM

For any information concerning British Brimar Valves, write without obligation to:

STANDARD TELEPHONES & CABLES Pty. Ltd. (Inc. N.S.W.)

Wellington, Box 638—Christchurch, Box 983, Wanganui, Box 293—Auckland, Box 91W

TRADE WINDS

Collaro Ltd. recently sent to Australia and New Zealand their technical representative, Mr. E. T. Humby. During his short stay in this country Mr. Humby seized the opportunity to meet a cross-section of the radio trade and in particular endeavoured to ascertain the problems connected with record-playing equipment in this country.

In Wellington he made his headquarters with Russell Import Co. Ltd., New Zealand representative of Collaro, and demonstrated Collaro's latest product, RC500. The new unit met with general approval. Apart from general mechanical robustness, it incorporates features which virtually make it impossible to throw the changer out of adjustment even though the mechanism may suffer interference during the operating cycle, and the tone arm move in the opposite direction to that in which the player mechanism is moving. The trade was interested to know that British manufacturers are watching developments closely and that as the need arises record-playing equipment will be provided for the various types of records now under development.

Apart from the beneficial effect of Mr. Humby's visit on the New Zealand trade, he has returned to England with information of importance to Collaro, namely a first-hand knowledge of some of the problems to be confronted in New Zealand. Returning to Auckland by car via Napier and Rotorua, Mr. Humby not only managed to see some of our thermal activity but also to spend some time at Arapuni, the major generating station on the Waikato River.

* * *

In spite of the fire causing certain dislocation of routine, Electronic Navigation Ltd. report "business as usual" and convey, through these pages, thanks to the many business houses who have sent them expressions of sympathy.

* * *

Eric Nichols, late of Tasman Airways, has joined Electronic Navigation Ltd., Auckland.

* * *

Doug Hall of Dominion Laboratory, is back from his tour of Great Britain.

* * *

Wally Thompson, who for many years over varying periods has represented the Wellington Branch of the National Electrical and Engineering Co. Ltd., as town and country traveller, has now joined the staff of Wireless Service Co., Hastings, as manager. All good wishes, Wally, in your new sphere of activities.

Taking over from Wally as town traveller is Archie Anderson, whom we congratulate upon his promotion. Archie has had a thorough training at the Wellington branch, commencing as message boy, and graduating to the position of assistant storeman. After four years' active service in the Middle East, he returned to the National Electrical as counter salesman. With this sound grasp of his company's activities, we are sure that Archie will enjoy his new appointment.

* * *

PUBLICATIONS RECEIVED

C. and A. Odlin Ltd., brochure of circuits and components of Mullard receivers.

Russell Import Co. Ltd., pamphlet, The New Collaro Automatic Record Changer.

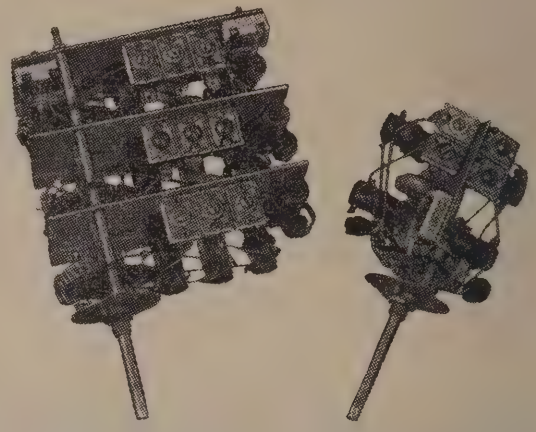
J. A. Oldfield, Wellington, M.E.M. Switchcraft catalogues.

Scott and Holladay, Wellington, catalogue of screening boxes and tubes for transformers and cathode ray tubes.

"Permalloy" catalogue of curves and electrical characteristics of nickel iron alloys. (Magnetic Electrical Alloys Ltd., England.) **(Continued on next page.)**

COMPACT—INEXPENSIVE—EFFICIENT

COIL ASSEMBLIES



HIGH "Q" COILS CYLINDER DUST CORES ON B.C. BAND ALIGNED IN ACTUAL RECEIVER MAKES A COMMERCIAL JOB OF A HOME-BUILT RECEIVER

CHASSIS—GANGS DIALS—I.F. TRANSFORMERS AVAILABLE AND SPECIALLY DESIGNED TO MATCH FULL CIRCUITS SUPPLIED TYPES FOR A.C. AND BATTERY TUBES

TYPE 24A D.W. SINGLE PRE-SELECTOR STAGE, 540 to 1600 kc/s., 6 to 20 mc/s.— **£4/3/11**

TYPE 34A D.W. WITH R.F. STAGE, 540 to 1600 kc/s., 6 to 20 mc/s.— **£6/2/8**

TYPE 64A T.W. WITH R.F. STAGE, 540 kc/s. to 20 mc/s. in three bands— **£6/13/9**

The finest assemblies in New Zealand. Be Sure — Be Satisfied — Use "Q."

Inductance Specialists

(The N.Z. High-frequency Coil Specialists)

202 THORNDON QUAY, WELLINGTON

OBITUARY

It is with deep regret that we report the death on 8th February, by accidental drowning in Te Aro Baths, of John Stretch. For many years a well known serviceman with Preston Billing Ltd., John Stretch joined the radio staff of Messrs. Turnbull & Jones Ltd. about eighteen months ago and was held in high esteem by his employers and fellow staff members alike.

NEW ZEALAND RADIO MANUFACTURERS' FEDERATION

Group photograph taken at Wairakei on the occasion of the 1949 Annual Conference (December). Reading from left to right, top row: D. A. Clarke (Group Secretary), A. Clive Johns, D. Reid, W. I. Cunningham, E. Burns, T. J. F. Spencer, J. Carpenter, T. R. Gobby, D. T. Clifton Lewis, L. Wright, F. W. Mountjoy; bottom row: Mrs. T. R. Gobby, Mrs. Wm. J. Blackwell, Wm. J. Blackwell (President), P. C. Collier (Vice President), Mrs. P. C. Collier, Mrs. F. W. Mountjoy.

The Federation reports that the latest production and sales figures available from U.S.A. show that the self-styled experts who predicted that television would seriously curtail the sale of radio sets, have been confounded.

Ever since last August radio sales continued at a torrid pace and shortages of radio sets are now becoming acute in practically every trading area. For 1950 it is anticipated that the annual market will stabilize at somewhere around ten million receivers, irrespective of the increasing television sales, which are now averaging about 312,000 per month.

* * *

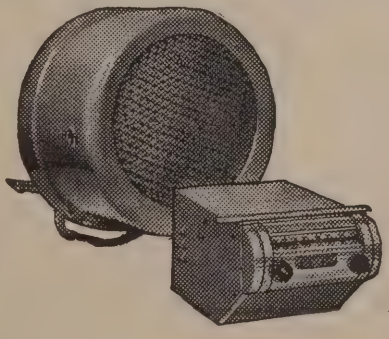
NEW ZEALAND RADIO TRADERS' FEDERATION NOTES

The Annual Meeting is fixed for Wednesday the 15th April, at the office of the Secretary, 8–12 The Terrace, Wellington, when a full attendance of delegates from all districts is expected.

Nelson, Canterbury, Wellington, Hawke's Bay, Taranaki Provincial Distributors:

AUTOCRAT DISTRIBUTORS, LTD., 20 Victoria St., Wellington

Otago and Southland: ELECTRIC & PLUMBING SUPPLIES, Ltd., 149 Stuart St., Dunedin



'AUTOCRAT' CAR RADIO

Retail Price £34-9-0

SIX-VALVE RECEIVERS BUILT TO WITHSTAND THE ROUGHEST CONDITIONS TO BE EXPERIENCED IN NEW ZEALAND

Special and exclusive Autocrat features ensure perfect reception under the most adverse conditions. We stand confidently behind any demonstration a prospective buyer may require. Note these features: High gain aerial circuit, latest metal type valves, low current drain—4½ amps. 6 volt or 2¼ amps. 12 volt.

Manufacturers:

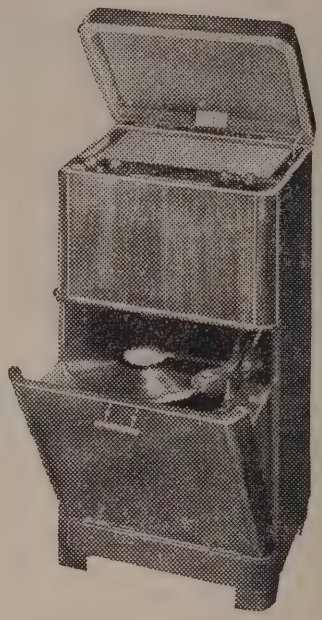
AUTOCRAT RADIO LTD.

PHONE 48-180 118 VICTORIA STREET, AUCKLAND

ULTIMATE 'Challen' Radiogram

SENSATION AT AUCKLAND EMPIRE GAMES CARNIVAL EXIBITION

Extraordinary interest was displayed towards this outstanding radiogram recently at the Empire Games Carnival Exhibition in Auckland. Hundreds praised its compact design, superb finish, and glorious tone. There is a big demand for this outstanding Ultimate model — the lowest-priced quality console radiogram on the market. Be sure your stocks include "Challen."



THE INCOMPARABLE "CHALLEN" WITH PIANO ACOUSTIC CABINET.

BY

ULTIMATE

Manufactured by

RADIO (1936) Ltd. Quay ST .AUCKLAND

RADIO CLASSES

If you wish to become a Marine Radio Operator, Broadcast Technician, Radio Serviceman, or Electronic Engineer, day or evening classes are open to you at—

NEW ZEALAND RADIO COLLEGE

24-26 Hellaby's Buildings - Auckland, C.1.

RADIART CO.

22 BRANDON ST., WELLINGTON

Special Transformers

Let us quote you for that Transformer which is NOT a stock size. We specialize in the odd varieties, including Audio Transformers and Smoothing Chokes.

PROMPT ATTENTION GIVEN

SIEMENS

ELECTRIC LAMPS

•

PLANNED LIGHTING

SIEMEN'S LAMPS ARE MADE BY EXPERTS and COMPLY IN ALL RESPECTS WITH THE SPECIFICATIONS OF THE BRITISH STANDARDS INSTITUTE.

•

PLANNED LIGHTING WITH **SIEMEN'S LAMPS** and **BENJAMIN CORRECTLY-DESIGNED REFLECTORS** ENSURES THAT ELECTRICITY IS USED AS ECONOMICALLY as POSSIBLE CONSISTENT WITH EFFICIENCY AND ADEQUATE ILLUMINATION.

CORY-WRIGHT & SALMON LTD.

WELLINGTON

AUCKLAND DUNEDIN

VARIABLE SELECTIVITY

Continued from Page 13.

455 kc/sec. When this has been done, there is nothing to do to the tuning slugs in the broad position. We merely take what the new coupling condenser gives us, relying on the design of the unit to keep the first transformer properly tuned to 455 kc/sec. Any temptation to fiddle with the tuning adjustments after switching to broad should be strenuously resisted, because with over-coupled transformers, there is just no way at all of tuning the windings properly, since each reacts upon the other. At first, the set may sound as though it is mis-tuned, but it will not be, and the effect is simply that of hearing high-frequency components in the programme, such as record hiss, that on a normal set are heard only when it is mis-tuned.

MORE THAN TWO SELECTIVITY POSITIONS

Although this was not mentioned in the original patent specification referred to earlier in the article, it is possible to extend the same principle to embrace any desired number of selectivity positions. The basic circuit for three such positions is given in Fig. 5. This time a two-pole switch is needed, and an extra two fixed condensers. A look at the diagram will show that irrespective of the switch position, the same tuning capacity is presented to each coil, provided that the condensers C_1 and C_2 are equal, respectively. A practical circuit for this arrangement can follow exactly the one for the two-position control. The reader can work out for himself the values needed for a three-point system, since the only two equations needed have been given above. Of course, although we have worked out our example on the assumption that the coils have a Q of 100, it does not follow that the coils that are bought will have this value. It is thus a good idea to find from the manufacturer, if possible, what the Q of the individual windings of his transformers is, actually wired into a circuit, since the wiring and the valve and its socket reduces somewhat the value obtained on a Q-meter, for the winding itself. With this figure, it will be found a simple matter to design the selectivity switching circuit, especially if text-books are consulted that give universal selectivity curves for over-coupled circuits.

In any case, at an early date, we hope to publish details of a set using the system described in this article, and constructors will find it a simple matter to duplicate the results obtained in our laboratory.

PUBLICATIONS RECEIVED

Continued from Page 15.

for the maximum permissible hum voltage at the grids of the valves throughout a receiver. Microphonic effects are also treated more comprehensively than we can remember having seen elsewhere.

Altogether, this is a most instructive and useful reference book, which should appeal genuinely to a wide section of those interested in the use of valves.

ALL-WAVE SEVEN

Continued from Page 7.

Particular note should be taken of the grid and screen stopper resistors in the output tubes. The older types of output valve did not need these, but modern high-Gm valves should always have them included, for without them, the audio amplifier may sometimes burst into most unaccountable oscillation at the most unlikely frequencies —often above 30 kc/sec.

(To be Concluded.)

CLASSIFIED ADVERTISEMENTS

FOR SALE.—"Hams." Hallicrafter 9-tube Model S39 Portable. 110, 230, and battery. As new. Any trial. £40 or near offer. Phone, 9 a.m.-5.30 p.m., Baker, 43-442, Wellington.

●

FOR SALE.—Two Communication Type Receivers, hardly used and in new condition; Hammarlund Super Pro. 16 Tubes; £80 or near offer. Hallicrafters SX17, 13 Tubes, £60 or offer. Details from Verne Mathie, Radio Service, Oamaru.

CABINETS RACKS CHASSIS

Calverts can supply any type of metal cabinet, Rack or Chassis, and will quote on special jobs.

Make use of Calvert's Specialized Skill in Metal.

CALVERTS LIMITED

138 *Tuam Street, Christchurch*

There is an immediate appeal to the housewife in the complete line of Hayman Electric Laundry Aids. They banish hard work, they are very safe, and they are gaining steadily in popularity.

LIBERAL DISCOUNTS TO THE TRADE

For agency arrangements, write to the Master Distributors:

Appliance Distributors Ltd.

144-6 Victoria Street, West Auckland.

INDEX to RADIO and ELECTRONICS Volume 4

SUBJECT	No.	No.
Abstract Service, The *Radio and Electronics*	1	26
" " "	2	13
" " "	3	21
" " "	4	28
" " "	5	28
" " "	6	21
" " "	7	21
" " "	8	21
" " "	9	38
" " "	10	13
" " "	11	41
" " "	12	35
Acoustics and Reproduction of Sound (J. N. Norman)	11	34
A.C. Battery Portable Design for (Questions and Answers)	5	22
Adaptor—A Modification to the *Radio and Electronics* Panoramic	4	9
Adaptor—The R. and E. Panoramic (Questions and Answers)	6	9
Aerials—Some Unusual Short Wave Transmitting and Receiving	1	35
All-Wave Low-Noise Tuning Unit for Converter or a Double Conversion Superhetrodyne	3	9
Amateur Band, A Converter for the 144-148 mc/sec.	4	12
Amateur Band, A Trans/Rec. for the 420 mc/sec.—		
Part I	8	9
Part II	9	9
Amplifier, More About the Economy 10-Watt	1	13
Amplifier Stage, Voltage Relations in Class C	1	41
Amplifier, Some Troubles with an I.F. Amplifier (Questions and Answers)	3	28
Amplifier, A New High-quality Audio	4	20
Amplifier, The New High-quality Audio (Questions and Answers)	7	14
Amplifier, A High-fidelity (Questions and Answers)	7	14
Amplifier Again, The New High-quality Audio (Questions and Answers	8	31
Amplifiers, Modification to One of Our Earlier (Questions and Answers)	5	26
Amplifier, A Complete Circuit for the Exciter Straight (Philips Experimenter 21 (a))	5	24
Amplifier to Follow the Exciter—A 100-Watt Final (Philips Experimenter 21 (b))	5	25
Amplifier to Follow the All-band Exciter—A Final (Philips Experimenter 22)	6	24
Amplifier and Modulator, for the Philips Experimenter Transmitter, A Speech (Philips Exp. 23)	7	24
Amplifier, Wiring an Extension Speaker to Radio Set or	5	36
Amplifiers—A Frequency Compensated Three-step Attenuator for Use with Oscilloscope	8	17
Ampli-Tuner, The *Radio and Electronics*	7	7
Applications of the 8012, Some	2	8
Attenuator for use with Oscilloscope, A Three-step Frequency Compensated	8	17
Audio,A New Way of Using 807's, 120 Watts	8	27
Audio, Signal Generator, The Radel—		
Part I	10	4
Part II	11	17
Part III	12	15
Automatic Weather Reporting Station (G. J. Wood)	12	4
Baffle Again, The Vented (Questions and Answers)	3	28
Bandspread Tuner, The 80–40–20—		
Part I	9	4
Part II	10	9
Questions and Answers	12	39
Beginners' Course, A Practical—		
Part 30	1	31
" 31	2	27
" 32	4	32
" 33	5	15
" 34	6	45
" 35	7	44
" 36	9	46
" 37	10	22
" 38	11	46
" 39	12	31
Blackwell, Wm. James, "Swan's" New Chief	7	12
Broadcast Four, The Radel (A Four Valve Receiver With a Five Valve Performance	3	4
Broadcast, Field Strength Survey, A (Editorial)	6	2
Broadcast D.X. 12, A Modified (G. R. Gilbert)	9	14
Broadcast Receiver Type 617P, Pacemaker (Serviceman's Section)	9	22
Broadcast Vibrator Receiver, A Five-valve—		
Part I	8	4
Part II	9	28
Britain and the Export Market (Editorial)	8	2
Building the *Radio and Electronics* 144 mc/sec. Converter	6	6
Cathode Follower Output Stage (Questions and Answers)	2	20
Chokes for Speaker Dividing Networks, Air-cored	6	34
Circuit, A Versatile Tone Control—		
Part I	5	4
Part II	6	29
Circuit, A New Low-noise Mixer Triode	1	4
Circuit for the Exciter's Straight Amplifier, A Complete (Philips Experimenter No. 21 (a))	5	24
Circuit for Getting Controllable Output Voltage from an Ordinary Power Supply	5	43
Circuit, A Simple Volume Indicator	7	9
Circuit, Trouble with an Oscilloscope Shift (Questions and Answers)	9	20
Circuit, An Untuned Diode Detector (Questions and Answers)	5	22
Circuit, Values for a (Questions and Answers)	12	37
Climatic Durability Tests for Radio Components, —An Industry Specification	4	40
Columbus Model 42, (Servicemen's Section)	8	32
Columbus Model 27, (Servicemen's Section)	10	41
Communications Receiver, The Junior (Part III)	1	17
Communications Receiver, The Junior (Questions and Answers)	6	38
Communications Receiver, Modifications to the Junior (Questions and Answers)	2	20
Communications Receiver, The Rainbow	2	4
Communications Receiver Design (Questions and Answers)	12	37
Component Makers and Users, Radio	6	10
Condenser Leakage and Its Effects (Aerovox Corp.)	7	17
Converter for the 144–148 mc/sec. Amateur Band	4	12
Converter, Building the R. and E. 144 mc/sec.	6	6
Design for an A.C./Battery Portable (Questions and Answers)	5	22
Design Sheet No. 6, Phase Shift Oscillator for Frequencies up to 100 kc/sec.	3	16
Design Sheet No. 8, Power Dissipated in a Resistance	4	36
Design Sheet No. 8A, Power Dissipated in a Resistance, Second Chart	5	32
Design Sheet No. 9, Air Cored Chokes for Speaker Dividing Networks	6	34
Design, Communications Receiver (Questions and Answers)	12	37
Direct Current Meter (Aerovox Corp.)	12	26
Dividing Networks for Loudspeaker Systems	6	14
Dividing Networks, Air-cored Chokes for Speaker (Design Sheet No. 9)	6	34
Dividing Networks, Speaker (Questions and Answers)	7	14
Dividing Networks, Speakers for Use With (Questions and Answers)	9	19
Dividing Networks, Wire for (Questions and Answers)	9	20
Domestic Appliances, The Suppression of (Belling and Lee)	10	17
Durability Tests for Radio Components, Climatic and, —An Industry Specification	4	40
Eddystone 640, The (Servicemen's Section)	6	39
Editorials—		
The S. Meter, Is it Worth It?	1	2
Electronics in Heavy Engineering	2	2
A New Publication	3	2
Broadcasting and the Radio Manufacturer	4	2
Television in New Zealand	5	2
A Broadcast Field Strength Survey	6	2
Quality Reproductions in High-priced Domestic Sets	6	2
A New Zealand "Rider's" Manual	7	2
Britain and the Export Market	8	2
A Problem to be Solved	9	2
Christmas Greetings	10	2
A New Radio Frequency Measuring Device	11	2
A New Service to Readers of *Radio and Electronics*	12	2
Editor's Opinion—		
The Plessy Midget I.F. Transformers	1	43
The "Reslo" Type P.G.D. Dynamic Microphone	3	27
8012, Some Applications of the	2	8
8012, Availability of Type (Questions and Answers)	12	37
807's, 120 Watts Audio, A New Way of Using	8	27
Electronics in Heavy Engineering (Editorial)	2	2
Electronic Switch, Two Pictures at Once on Same Cathode Ray Tube	2	16
Errors in a Circuit (Questions and Answers)	5	22
Extension Speaker to a Radio Set or Amplifier, Wiring an	5	36
Exciter Unit for 80 to 10 Metres Inclusive, A Four-band (Philips Experimenter No. 18)	2	46
Exciter Unit for 80 to 10 Metres Inclusive, A Four-band (Philips Experimenter No. 19)	3	46
Exciter Unit for 80 to 10 Metres Inclusive, A Four-band (Philips Experimenter No. 20)	4	46
Exciter Straight Amplifier, A Complete Circuit for the (Philips Experimenter No. 21A)	5	24
Exciter, A 140-Watt Final Amplifier to follow the (Philips Experimenter No. 21B)	5	25
Exciter, A Final Amplifier to follow the All-band (Philips Experimenter No. 22)	6	24
Exciter for the 2-Metre Amateur Band, A Six watt Transmitter or	3	13
Export Market, Britain and the (Editorial)	8	2

Four-band Exciter Unit for 80 to 10 Metres Inclusive, A (Philips Experimenter No. 18) 2 46
Four-band Exciter Unit for 80 to 10 Metres Inclusive, A (Philips Experimenter No. 19) 3 46
Four-band Exciter Unit for 80 to 10 Metres Inclusive, A (Philips Experimenter No. 20) 4 26
Five-inch Oscilloscope Employing Unit Construction, A Part 6, Distortion Measurement 1 29
Five-valve Broadcast Vibrator Receiver 8 4
Frequency for a Mine Detector (Questions and Answers) 2 22
Frequencies, N.Z. Amateur Transmitting (Questions and Answers) 12 37
Frequency Measuring Device, A New (Editorial) 11 2
High-quality Audio Amplifier, The New 4 20
High-quality Audio Amplifier, The New (Questions and Answers) 7 14
High-frequency R.F. Chokes, Specifications for Winding Chokes for Bands above 30 mc/sec. 4 10
High-stability V.F.O., A (Part II) (Philips Experimenter No. 17) 1 10
Hum in Heater-Cathode Valves 4 40
Index to *Radio and Electronics*, Volume 3 1 45
Inter-Com. The "Radel" 5 9
Inter-Com., Constructing the "Radel" 6 12
Loudspeaker Systems, Dividing Networks for 6 14
Low-Noise Mixer Triode Circuit, A New 1 4
Measuring Device, A New Radio Frequency (Editorial) 11 2
Meter, Is It Worth It? The S. (Editorial) 1 2
Meter, Direct Current (Engineering Dept. Aerovox Corporation) 12 26
Microwave Vehicle Speed Indicator (A. G. Bogle) 9 36
Mixer, Triode Circuit, A New Low Noise 1 4
Modifications to the Junior Communications Receiver (Questions and Answers) 2 20
Models, Radio Control of (L. H. Wright)—
Part I 7 4
Part II 10 33
Modulator for the Philips Transmitter, A Speech Amplifier and (Philips Experimenter No. 23) 7 24
Modulation, Construction and Power Supply Circuit of the 50-Watt (Philips Experimenter No. 25) 9 24
Multivibrators, for Pleasure and Profit 10 29
Neon Bulb, A Simple Stroboscopic Lamp Using a 5-Watt 11 9
New Products—
Courtenay Model 27 Grenville 7 43
Grover Two-in-one Tapon 7 43
Courtenay Model 61, Sussex 9 47
A.W.V. Type 6AR7-GT 9 47
Sound Mirror 9 47
Courtenay Model 90, Renown 10 46
Courtenay Model 19, Ajax 11 43
New High-gain Converter Valve Radiotron Type X61M 11 43
Courtenay Model 5, Talisman 12 47
Philco Model 860 (8-Valve A.W.) 12 47
N.Z. Electronics Institute Newsletter 5 35
" " " " 6 47
" " " " 7 28
" " " " 8 36
" " " " 9 32
" " " " 10 44
" " " " 11 39
" " " " 12 8
N.Z. "Rider's" Manual, A (Editorial) 7 2
N.Z. Radio Manufacturers' Federation Notes 8 34
N.Z. Radio Traders' Federation, Annual Conference 2 44
N.Z. Radio Traders' Association, Annual Meeting of the Auckland 8 35
N.Z. Radio Traders' Federation, A Message from the President, Decontrol of Prices 11 29
Noise Interference, Radio Manufacturers Concerned 12 40
Noise Suppression, One of the Latest Advances in Audio Technique, Dynamic 12 17
Ohm Meters, A Point About (Questions and Answers) 4 42
Oscillators for Frequencies up to 100 kc/sec, Phase Shift, Design Sheet No. 6 3 16
Oscilloscope Employing Unit Construction, A Five-inch, Part 6, Distortion Measurement 1 29
Oscilloscope Amplifiers, A Frequency Compensated Three-step Attenuator for Use with 8 17
Oscilloscope Problems, Some (Questions and Answers) 2 21
Oscilloscope Shift Circuit, Trouble with (Questions and Answers) 9 20
Output Voltage, A Power Supply with Controllable 4 6
Output Voltage from an Ordinary Power Supply, A Circuit for Getting Controllable 5 43
Output Stage, Cathode Follower (Questions and Answers) 2 20
Pacemaker Broadcast Receiver, Type 617P. 9 22
Panoramic Adaptor, A Modification to the R. & E. 4 9
Panoramic Adaptor, The R. & E. (Questions and Answers) 6 9
Performance Figures for Types 6V6, 6F6,, and 6N7 in the Electronic Voltage Divider Circuit 7 46
Phase Shift Oscillators for Frequencies up to 100 kc/sec., Design Sheet No. 6 3 16
Philips Radioplayer Model 209 (Servicemen's Section) 7 33
Philips Radioplayer Model 648 (Servicemen's Section) 3 18
Philips Model 461 (Servicemen's Section) 5 20
Philips Experimenter—
No. 17 A High-stability V.F.O., Part II 1 10
No. 18 A Four-band Exciter Unit for 80–10 metres inclusive 2 46
No. 19 A Four-band Exciter Unit for 80–10 Metres inclusive 3 46
No. 20 A Four-band Exciter Unit for 80–10 Metres inclusive 4 46
No. 21 (*a*) Complete Circuit for the Exciter's Straight Amplifier 5 24
No. 21 (*b*) A 100-Watt Final Amplifier to Follow the Exciter 5 25
No. 22 A Final Amplifier to Follow the All-band Exciter 6 24
No. 23 A Speech Amplifier and Modulator for the Philips Transmitter 7 24
No. 24 A Miniature M.O.P.A. Transmitter for Battery-operated Transmitters or Transmitter Receivers 8 44
No. 25 Construction and Power Supply Circuit of the 50-Watt Modulator 9 24
No. 26 Complete Power Supply and Sequence Switching for the Philips 100-Watt Transmitters 10 24
No. 27 Setting up and Adjusting the Sequence Switching Relays of the Philips 100-Watt Transmitter 11 24
No. 28 (*a*) Construction of the Power Supply Unit 12 24
No. 28 (*b*) Aerial Feed and Matching Construction of the Power Supply Unit) 12 24
Picture Telegraph Equipment in Use in New Zealand 4 4
Portable Competition, The Second Prize Winning Design in the *Radio and Electronics* 1 21
Portable Design for an A.C./Battery (Questions and Answers) 5 22
Portable Five, The Radel 1950 11 4
Portable Sound System, A (D. Brook-Taylor) 12 9
Power Supply with Controllable Output Voltage 4 6
Power Dissipated in a Resistance, Design Sheet No. 8 4 36
Power Dissipated in a Resistance, Design Sheet No. 8 (*a*) Second Chart 5 32
Power Supply, A Circuit for Getting Controllable Output Voltage from an Ordinary 5 43
Power Supply and Sequence Switching for the Philips 100-Watt Transmitter, Complete (Philips Experimenter No. 26) 10 24
Power Supply Circuit for the 50-Watt Modulator, Construction and (Philips Experimenter No. 25) 9 24
Power Supply Unit, Construction and Aerial Feed and Matching Construction (Philips Experimenter 28 (*a*) and (*b*) 12 24
Practical Beginners Course, A—
Part 30 1 31
" 31 2 27
" 32 4 32
" 33 5 15
" 34 6 45
" 35 7 44
" 36 9 46
" 37 10 22
" 38 11 46
" 39 12 31
Pre-amplifier, An Unusual (Questions and Answers) 4 41
Pre-amplifier for Modern Gramophone Pick-ups, A Versatile 8 11
Pre-amplifier, Constructing the Versatile 9 17
Publication, A New (Editorial) 3 2
Publications Received—
Frequency Analysis, Modulation and Noise 1 32
Television Production Problems 1 32
Waveforms, Vol. 19 of the I.T. Radiation Lab. Series 5 27
Electronic Time Measurements 6 33
Essentials of Radio (Slwizberg & Osterheld) 8 38
Electronics Manual for Engineers (1st Edition, Vin Zeluff and John Markus) 9 26
Physical Aspects of Colour (Dr. P. J. Bouma) 9 27
Push Button Tuner for High-quality Reception 6 4
Quality Reproduction in High-priced Domestic Sets (Editorial) 6 2
Questions and Answers—
Cathode Follower Output Stage 2 20
Modifications to Junior Communications Receiver 2 20
Some Oscilloscope Problems 2 21
Frequency for a Mine Detector 2 22
Some Troubles with an I.F. Amplifier 3 28
The Vented Baffle Again 3 28
The Radel Single-Twin 3 28
An Unusual Pre-Amplifier 4 41
A Point About Ohm Meters 4 42
Errors in a Circuit 5 22
An Untuned Diode Detector Circuit 5 22

Design for A.C./Battery Portable 5 22
Modification of One of Our Earlier Amplifiers 5 26
The R. and E. Panoramic Adaptor 6 9
Presentation of Valve Data 6 37
Junior Communications Receiver 6 38
Speaker Dividing Networks 7 14
The Radio and Electronics Valve Tester 7 14
A High-fidelity Amplifier 7 14
The New High-quality Audio Amplifier 7 14
How an Ordinary Shunt Rectifier Works 8 29
The New High-quality Audio Amplifier Again 8 31
Speakers for Use with Dividing Networks 9 19
Trouble with an Oscilloscope Shift Circuit 9 20
Wire for Dividing Networks 9 20
Values for a Circuit 12 37
Availability of Type 8012 ..... 12 37
N.Z. Amateur Transmitting Frequencies 12 37
Communications Receiver Design 12 37
80–40–20 Bandspread Tuner 12 39
R. & E. 420 mc/sec. Transmitter Receiver 12 40
Radel Broadcast Four, The (A Four-valve Receiver with a Five-valve Performance) 3 4
Radel Single Twin (Questions and Answers) 3 28
Radel Inter-Com., The 5 9
Radel Inter-Com., Constructing the 6 12
Radel Audio Signal Generator—
Part I 10 4
Part II 11 17
Part III 12 15
Radel 1950 Portable Five 11 4
Radel Transportable Three 12 7
Radio and Electronics Ampli-Tuner 7 7
Radio and Electronics Portable Competition, The Second Prize-winning Design in the 1 21
Radio and Electronics 144 mc/sec. Converter, Building the 6 6
Radio and Electronics Valve Tester, the (Questions and Answers) 7 14
Radio Components, Climatic and Durability Tests for—An Industry Specification 4 40
Radio Component Makers and Users, How Closer Liaison Has Improved the Product 6 10
Radio Control of Models (L. H. Wright), Part I 7 4
Radio Control of Models (L. H. Wright), Part II 10 33
Radio Frequency Measuring Device, A New (Editorial) 11 2
Radiolympia, Non-Commercial Exhibits at the 1949 12 46
Radio Set or Amplifier, Wiring an Extension Speaker to 5 36
Radio Traders' Federation, Annual Conference of the N.Z. 2 44
Receiver, The Junior Communications (Part III) 1 17
Receiver, The Junior Communications, Modifications to 2 20
Receiver, The Junior Communications (Questions and Answers 6 38
Receiver, The Rainbow Communications 2 4
Receiver Type 617P, Pacemaker Broadcast (Servicemen's Section) 9 22
Receiver, A Five-valve Broadcast Vibrator 8 4
Receiver, A Five-valve Broadcast Vibrator 9 28
Receiver Circuits, The First of a New Series of Commercial (Servicemen's Section) 3 18
Receiving Aerials, Some Unusual Short-wave Transmitting and 1 35
Reception, A Push Button Tuner for High-quality 6 4
Receiver Design, Communications (Questions and Answers) 12 37
Reproduction of Sound, Accoustics and (J. N. Norman) 11 34
R.F. Chokes, High Frequency Specifications for Winding Chokes for Bands Above 30 mc/sec. 4 10
Rectifier Works, How an Ordinary Shunt (Questions and Answers) 8 29
"Rider's" Manual, A New Zealand (Editorial) 7 2
Servicemen's Section—
Philips Radioplayer, Model 648 ..... 3 18
The Ultimate 6-Valve B/C Loop Model R.A.G. 4 18
The Ultimate 6-Valve Dual-wave 1948 Model R.W. 5 18
Philips Model 461 ..... 5 20
The Eddystone 640 ..... 6 39
The Philips Radioplayer Model 209 ..... 7 33
The Columbus Model 42 ..... 8 32
Pacemaker Broadcast Receiver Type 617P 9 22
Columbus Model 27 ..... 10 41
Ultimate 7-Valve Bandspread Model R.O. 11 15
The Ultimate 5-Valve Radiogram Consolette Model R.A.F. 12 22
Short-wave Transmitting and Receiving Aerials, Some Unusual 1 35
Signal Generator, The Radel Audio—
Part I 10 4
Part II 11 17
Part III 12 15
Six-Watt Transmitter or Exciter for the 2-Metre Band 3 13
S-Meter, The. Is it Worth It? (Editorial) 1 2
Sound System, A Portable (D. Brook-Taylor) 12 9
Speaker Dividing Networks, Air-Cored Chokes for (Design Sheet No. 9) 6 34
Speaker Dividing Networks (Questions and Answers) 7 14
Speakers for Use with Dividing Networks (Questions and Answers) 9 19
Specifications for Winding H.F. R.F. Chokes for Bands above 30 mc/sec. 4 10
Speed Indicator, A Micro Wave Vehicle (Dr. A. G. Bogle) 9 36
Stroboscopic Lamp, Using a 5-Watt Neon Bulb, A Simple 11 9
Superhetrodyne, An All-wave Low-noise Tuning Unit for a Converter or a Double Conversion 3 9
Super Modulation Principle, The Taylor 7 31
Suppression, Noise. One of the Latest Advances in Audio Technique 12 17
Suppression of Domestic Appliances (Belling Lee) 10 17
Swann, Norman W., A Popular Figure Retires 7 35
Switch, An Electronic (Two Pictures at Once on Same Cathode Ray Tube) 2 16
System, A Portable Sound (D. Brook-Taylor) 12 9
Taylor Super Modulation Principle, The 7 31
10-Watt Amplifier, More About the Economy 1 13
Television in New Zealand (Editorial 5 2
Television Trends in the Dominion 12 33
Tone Control Circuit, A Versatile 5 4
Tone Control Circuit, A Versatile (Part II) 6 29
Transmitter or Exciter for the 2-Metre Amateur Band, A 6-Watt 3 13
Transmitter Receiver for the 420 mc/sec. Amateur Band—
Part I 8 9
Part II 9 9
Questions and Answers 12 40
Transmitter for Battery-operated Transmitters or Transmitter/Receiver. A Miniature M.O.P.A. (Philips Experimenter No. 24) 8 44
Transmitter, Complete Power Supply and Sequence Switching for the Philips 100-Watt (Philips Experimenter No. 26) 10 24
Transmitters, Setting up and Adjusting the Sequence Switching Relays of the Philips 100-Watt (Philips Experimenter No. 27) 11 24
Transmitting and Receiving Aerials, Some Unusual Short-wave 1 35
Transmitting Frequencies, N.Z. Amateur (Questions and Answers) 12 37
Transportable Three, The Radel 12 7
Tube Data—
The 8012 VHF Transmitting Triode 1 38
Characteristics of the Loktal Output Beam Power Amplifier Type 7C5 ..... 1 39
The 7S7 Triode-Hexode Oscillator-Mixer Tube 2 30
The 7B7 Remote Cut-off R.F. Pentode 3 30
The 7C6 Duodiode High-mu Triode 4 30
The 7Y4 Loktal Full-wave Rectifier 5 30
The VT-191 Door Knobs VHF Transmitting Triode 7 27
A Complete List of Current Miniature Valves 9 33
A New Triode-hexode Frequency Converter 10 37
The 3D6/1299, A VHF Battery Triode 11 27
Tuner for High-quality Reception, A Push Button 6 4
Tuner, The *Radio and Electronics* Ampli- 7 7
Tuner, The 80–40–20 Bandspread—
Part I 9 4
Part II 10 9
Questions and Answers 12 39
Tuning Unit for a Converter or a Double Conversion Superhetrodyne, An All-wave 3 9
Ultimate 7-Valve Bandspread Model R.O. (Servicemen's Section) 11 15
Ultimate 6-Valve Dual-wave 1948 Model R.W. (S.S.) 5 18
Ultimate 6-Valve B/C Loop Model R.A.G. (S.S.) 4 18
Ultimate 5-Valve Radiogram and Consolette Model R.A.F. (Servicemen's Section) 12 22
Unit Construction, A Five-inch Oscilloscope Employing (Part 6) Distortion Measurement 1 29
Valve Data, Presentation of (Questions and Answers) 6 37
Valves, Hum in Heater Cathode 4 40
Valve Tester, The *Radio and Electronics* (Questions and Answers) 7 14
Values for a Circuit (Questions and Answers) 12 37
Vehicle Speed Indicator, A Microwave (Dr. A. G. Bogle) 9 36
Vented Baffle Again, The (Questions and Answers) 3 28
Versatile Pre-amplifier for Modern Gramophone Pick-ups 8 11
Versatile Pre-amplifier, Constructing the 9 17
Versatile Tone Control Circuit, Part I 5 4
Versatile Tone Control Circuit, Part II 6 29
V.F.O. A High Stability, Part II (Phil. Exp. No. 17) 1 10
Vibrator Broadcast Receiver, A Five-valve 8 4
Vibrator Broadcast Receiver, A Five-valve, Part II 9 28
Voltage Divider Circuit, Performance Figures for Types 6V6, 6F6, and 6N7, in the Electronic 7 46
Voltage Relations in Class C Amplifier Stage 1 41
Volume Indicator Circuit, A Simple 7 9
Weather Reporting Station, An Automatic (G. J. Wood) 12 4
Wiring an Extension Speaker to a Radio Set or Amplifier 5 36

WHEN YOU CAN SEE, YOU'RE SAFE!

That's the slogan the pressure of "Eveready" Advertising is directing at Mr. and Mrs. Battery Buyer. When people *see* "Eveready" Batteries, it's *safe* to say they'll buy . . . so display batteries prominently, together with "Eveready" advertising material.

Alert retailers . . . GET YOUR SHARE of the business, by stocking up *early* to meet the demand in coming months!

EVEREADY
TRADE-MARK
MINI-MAX
TRADE-MARK
RADIO & FLASHLIGHT BATTERIES

TCC
CONDENSERS
You see them
in all of the
BEST SETS
New Zealand Distributors:
TURNBULL and JONES LTD.
Auckland - Wellington - Christchurch - Dunedin
Hamilton - Palmerston North - Invercargill